# General Systems Theory

## A Focus on Computer Science Engineering

**Dougglas Hurtado Carmona**

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ISBN: **978-1-257-78224-6**

Translated from:
**Teoría General de Sistemas: Un enfoque hacia la ingeniería de sistemas.**
© **2010.** ISBN: **978-958-44-6487-3**

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# By way of prologue

Probably because of our helpful, warm, rising, uninterrupted and stimulating relationship we have built over the past 12 years, "referenced" by the exciting academic activities common to our work in this journey full of feverish, dramatic and diligent actions linked to the "production" of the top engineers in these technologies, modern and captivating, which unquestionably TIC's Clothing and dragging the world of today and tomorrow, the author of the present text, likely fueled by his proverbial generosity, I said the task to concoct some quick and brief way introitus dimensions to its intense, continuous and meticulous scholarly work wonderfully framed in the construction of relevant knowledge and its transmission to the generations that are to mark, to structure and guide them with a vision of transcendence towards society, in these appalling disciplines.

Going against the conventional schemes set out in this kind of exercise, when induced to future readers, whether they be students, teachers, researchers, professionals related to these disciplines guided by the latest technology framed in the so-called knowledge society, preceded the the Information Society that erupted in 2000 with the explosion of the Internet that chain came after the development of post-industrial middle of last century and the Industrial Society itself with identifying or if you want the discovery of electricity in the early nineteenth century who revolutionized factory life and woke up buried artisanal production schemes and goods, which are feeding and which serves the players and leaders, I will not refer to the text that the author makes the demanding close scrutiny of the academic community: The 152 pages, seven chapters covering the General Systems Theory-Foundations for General Systems Theory, Fundamentals of Systems, System Dynamics Computer Modelling, Computer Modelling Concurrent, building models Client-Server Computing conceptual and philosophical essence of the proposal linked inexorably to the aspect of "neural" in the corner over the formation of a systems engineer with a holistic view, we, as it has not be-a who will address the study of General Systems Theory and the training framework, and in the research, now in the discussions and controversies own fascinating scholars from these disciplines, when touched and become involved in dissecting the consideration of proposed text society of scholars of Informatics and perhaps in other disciplines concurrently.

I wish if, draw up a quick touch on the unusual and important features that make it possible to approach the personality, its own profile and hence to their work. the author of the text commented: Born and educated in his early years in a rural par excellence, the municipality of Turbaco settled in the outskirts of Cartagena de Indias, parents from this population and Maria La Baja, also rural, who distinguished themselves in their own work devoted to the support and development partner of six children, with jobs in the National Police as well as in the wholesale of beer the man, and the development of the home itself and the woman responsible for marking tip as the last child of this large family. Sent to the provincial capital, attended high school in the Salesian school-very-distinguished academic advantage over those years among the most remarkable for its promotion and

evidenced a singular coincidence, which was the school where he would attend his secondary education and where he graduated as such, acted as a pioneer-to 1986-in available at that time a computer room in pairs exist at the time, slipping from those early years his curiosity, innate ability and interest in this discipline, just emerging in and strengthened our country in terms of calling for a close family friend, Don Jose Rodriguez or "Pepin" - who presciently sensed to be applied where the engineer in power.

The physical proximity and greater security in those years when the country was fighting a bloody battle against drug lords-1989 with the assassination of Luis Carlos Galan, 1990 and Beyond ", it was determined that the race was taken at Universidad del Norte disregarding the Industrial University of Santander (UIS) highly qualified and attractive to venture into this still new and perhaps unfamiliar discipline.

There, at the Universidad del Norte, the author forged his training of undergraduate and graduate student always standing on both journeys and Distinguished Fellow at the undergraduate as well as by the educational institution as the agreements with companies in the region stimulated talent as it was the foundation of such Mario Santodomingo conglomerate. In this, the Universidad del Norte, began studying for his growing and continued interest in systems theory and a paradox was not her guardian who induced him to travel on this career path because their teachings have never been to his liking, more if the subject itself began to interest you and excite since.

After working a short stay in Cartagena de Indias, and recent graduate of the first stage of their careers, linked from the beginning and continuously breaking our institution as a professor in the Systems Theory course, and soon after all disciplinary areas-career, this topic has made it since then and which has grown slowly and steadily, leading to the production of the text is now given to the academic community for tasting and rigorous scrutiny.

Now in its capacity as a researcher, his intellectual production has been devoted to develop and strengthen three specific topics, in which the Faculty of Engineering and the Foundation San Martín University's headquarters in Puerto Colombia, which through its umbrella of Dr. Jose Santiago Alvear has sponsored the publication of the book object of these dimensions with strong leadership and growing our strong academic and research activities, "mother and guide its tasks has been fortunate with enthusiasm and tenacity led to growing through its evolution: Theory Systems, Methodologies on Learning Objects, and Information Security.

Here's an incontrovertible paradigmatic example of this attractive development, dynamic and vigorous in this exciting production traffic on academic, intellectual and "engineering" of this wonderful specimen, who is part of our quarry prominent academic in the formation of the best and most

transcendent engineers of these brand new generations, who will surely contribute to the transformation and better being of our fellows with a witty and creative technology solutions.

And, in a parody of the jargon so fashionable dining by these Kalends, I predicted "Bon Appetit" its lucky readers.

Jorge A. García Torres
Dean Faculty of Engineering
Fundación Universitaria San Martín, Puerto Colombia headquarters

Barranquilla, April 29, 2010.

# *BASES ON THE GENERAL SYSTEMS THEORY*

Chapter

1

## REDUCTIONIST APPROACH

### Specialization

We say that a ***specialist*** professional knowledge is highly deepened when studying a small area of knowledge. That is, a cardiologist who is a specialist health be trained in good shape to solve problems concerning the human heart, and a lawyer, a law specialist, will help tackle problems judicial nature.

Specialization has entered the area of knowledge and society with great force, replacing the "Wise Men" of antiquity. Comparing the elementary schools of our parents and grandchildren, are in the first, a teacher who taught all subjects (biology, languages, mathematics, aesthetics, physical education, etc.). But in the latter, subjects are given by various teachers. Similarly, when we consulted a "generalist", a disease that afflicts us, we often "refer" to a specialist in a particular area of health. To where it wants that we watch, we found the specialization, in the work, the schools, the universities, etc. Thus, for the development of any project, specialists of different areas from the knowledge "join" themselves to develop it.

The knowledge areas that represent the expertise are those that focus on a "part" of other areas of knowledge, for example: Each of the Health Sciences (Dermatology, Urology, Histology, etc.), And Engineering (Mechanical Systems, Civil, Electronics, etc.). With specialization, the term Master Integral completely disappears to make room at the end ***specialist.***

### Reductionist theory

***Reductionist Theory*** is a methodological approach based on specialization. That is, this theory studies the complex phenomena based on the analysis of its parts [1]. This theory focuses on move from general to particular, and when we have a toothache, we went to dentist (Specialist in Human Teeth) and not the Dermatologist (Specialist in Human Skin).

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[1] Johansen, 1996

In fact, all undergraduate programs at universities are specializations of the total knowledge: the Masters are specialized studies of undergraduate programs; including doctorates so are the Masters and Postdoctoral are of doctorates.

It is known for the great contribution he has made to human knowledge reductionist theory, including the proper treatment of diseases, telecommunications, computer, etc., but it is also true that we do not enjoy the entire show to "specialize" ie, by reducing our object of study too.

Consequently, phenomenons exist like they are the ***Computer Systems*** that require to be analyzed as entireties, without losing of view the internal relationships; and they are not appropriately tried by the reductionist theory. In this type of phenomenons cannot be "known" neither to "predict" their behavior with the simple study of one on their behalves. For example, in the process of definition of the requirements of a software that must be built, it is impossible to determine them with the simple vision of a single user. It is necessary to keep in mind to all the users and clients, and also the relationships between them and their own necessities. When we analyze phenomenons with these characteristics we can fall in the imprudence and to generate missed knowledge and / or broken into fragments, originated the demand of additional resources to amend the error.

If we take as analyzes the behavior of a person in a given population, and we always results in that person complies with the traffic signals, would it be valid to say that everyone in the population also respect the traffic signals?

The great disadvantage of the reductionist theory is to generate ***Specialized Ears*** of specialists who have little communication with other disciplines, due to their knowledge so special. When their ears are more specialized, the lower your participation in a conversation between two or more professionals in different fields to study the same phenomenon. This is the case of a "conversation" between a lawyer and a physical star on worm holes.

# THE APPROACH OF GENERAL SYSTEMS THEORY

## Approaches to general systems theory

***System: Preliminary definition***

For now, a ***system*** is defined as the set of parts that interact together to achieve a goal. Own this definition would be: football teams whose objective is to score more goals than your opponent; a refrigerator, parts of which relate to maintaining a temperature within the same; and the human digestive system which aims to transform appropriate energy the food humans eat.

***Methodology of General Systems Theory***

The ***Methodology of the G.S.T.*** is based on the analysis of phenomena as wholes consisting of parts interacting with each other (systems). Also aims to integrate the analysis of the phenomenon parties to reach a logical whole, where, are important relations between them. Therefore, we argue that the G.S.T. has a methodological basis contrary to the reductionist approach[1].

In G.S.T. the study objects are treated as systems and therefore seeks to overcome the disadvantages of the reductionist theory, forming the so-called ***Generalized Ears***, and developing a framework containing a common language and to allow two or more specialists from different disciplines together to analyze a phenomenon. That is, these generalized ears will be able to "defend" in a communication for teamwork.

With this, the G.S.T. creates a new system, consisting of Generalized Ears (Parties) that communicate (interact) with each other, to analyze a phenomenon (Target). The situation is reflected in the case of a Working System for the construction of an information system, where the Software Engineer, Engineers from other disciplines, administrators, etc., must have the "protocols" right of communication for software development.

***Approaches of other authors***

***Von Bertalanffy***[2] defines G.S.T. as a logical-mathematical area whose mission is the formulation and derivation of principles that are applicable to systems in general.

For ***West Churchman***[3], the G.S.T. is a way of thinking about systems and their components. In studying a phenomenon must first identify the objective pursued, and only after its structure.

## Frameworks for the study of G.S.T.

To implement the fundamental concepts of TGS in the analysis of the phenomena must choose one of the benchmarks described below:

***First frame of reference***

The ***first frame of reference*** is to construct a theoretical model to represent general phenomena that are in different disciplines. In fact, seeks in essence conceivable systems reduce to a manageable number. For example, in all areas of human knowledge there are populations of individuals; the idea is to generate a model that is applicable and valid in the different disciplines that have to do with those populations.

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[1] To confront with Latorre,1996 and Johansen,1996
[2] Von Bertalanfy, 1978
[3] Churchman, 1973.

This framework provides an objective low ambition but with a high degree of confidence, trying to discover similarities in the theoretical constructions of different disciplines of knowledge, and developing theoretical methods applicable to at least two areas of study.

***Second frame of reference***

The second frame of reference consists of a hierarchy of knowledge disciplines in relation to the organizational complexity of their components at a level of abstraction.

This second framework, presents a target of high ambition and low confidence, it seeks to develop a set of interacting theories (System of Systems) in particular areas of human knowledge, directing research to fill gaps. Table 1 describes this System of Systems.[1].

## Trends of practical application of G.S.T.

Among the trends of practical application of general systems theory are the following disciplines: cybernetics, information theory, game theory, decision theory, systems engineering.

***Cybernetics***

***Cybernetics***[2] is the science that studies the transfer of information to the control and organization of systems. It uses the principles of feedback and homeostasis[3]. The objects of study of cybernetics are called ***cybernetic systems***, which have parts that promote and manage the organization and control within the same, to maintain a balance of the system.

The typical example is the human central nervous system, for informing the brain to make a sudden movement of the right hand is burning, it acts as a cybernetic system, because with this action prevents the imbalance of the system

***Information theory***

***Information Theory*** is the science that is responsible for reviewing the handling that gives information as a contribution to the organization and implementation of the objectives of the systems. Looking for an Accounting Information System, which has worked well for several years, but at some point the government has enacted new legislation amending the methods of payment of taxes, this information must be handled properly to to keep "alive" to the System. Hence, all information affecting a system must be taken into account to generate new information and actions that impact the survival of the system.

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[1] To confront with the description realised in Johansen, 1996
[2] Cybernetics. Developed by Norbert Weiner. Cybernetics. Cambridge Mass MIT Press. 1961
[3] Homeostasis. It is the property that presents the Systems to stay in balance.

**Table 1. Order of Hierarchy of the empirical Fields**

| Level | Examples |
|---|---|
| **Static systems:** They correspond to conceptual or theoretical systems | The Conceptual Models<br>The laws of Newton<br>Trigonometry |
| **Simple Dynamic systems:** They correspond to nonorganic systems that transform some type of energy | Solar System<br>The Volcanos<br>The Sea currents |
| **Cybernetic Systems or Control:** They are Systems that help others to fulfill their objectives. | The Thermostat<br>The Human Nervous System |
| **The Dynamic systems first Order:** Systems with a first degree of organization. | The cells<br>The Virus<br>The Bacteria |
| **The Dynamic systems second Order:** | The Flora generally |
| **The Dynamic systems 3° Order:** | The Fauna generally |
| **The Dynamic systems 4° Order:** | The Man |
| **The Dynamic systems 5° Order:** | A Company<br>A family |
| **The Dynamic systems 6° Order:** | The absolute thing |

***Game theory***

***Game Theory***[1] is the science, using mathematical models, study skills or clashes between various systems capable of "reasoning" in which each participant seeks to minimize system losses and maximize profits. Among the cases studied game theory are: Fighting Sports, suppliers of a product on the market (as War of soda), the strategies of two men trying to conquer a lady and a police pursuit.

[1] Developed by Von Neuman and Morgenstein

***Decision theory***

***Decision Theory*** is the science of fighting between various systems, where some are able to "reason" and others unable to do so, in addition, each participant system capable of "reasoning" seek to make decisions that optimize the results (to minimize losses and maximize profits). Therefore, we conclude that decision theory is a special case of the Theory of Games, where players are rational. The example that stands out the theory of rational decision as no participant is nature. Among the phenomena studied for Decision Theory are: methods to mitigate forest fires, the management of supply and market demand, and prediction of weather and earthquakes.

***Computer Systems engineering***

Carlos Trujillo[1] defines the Computer Systems Engineering as a discipline that aims to plan, design, test and build complex systems using the G.S.T. and engineering, as distinguished from the others Engineerings at its most integral character to examine the solution of problems.

Oscar Johansen[2] believes that Computer Systems Engineering concerns the planning, design, construction and scientific evaluation of human-machine systems.

For the author, Computer Systems Engineering is responsible for resolving problems, building automated information processing systems, under the approach of General Systems Theory using resources provided by engineering.

## FOCUS ART TO SOLVE PROBLEMS

In this section describe two approaches used in general systems theory in solving problems[3]. In the first instance, describes a formal procedure in which everything revolves around around the construction of models, and the second round of creativity. But first, let's define the concept of problem:

## What is a problem?

Is defined as a ***problem*** in the abstract difference is obtained by comparing the objectives with the results. Framing in the G.S.T., we can say that every system has goals to accomplish, if your product is different, conceptually to the objectives, it is said that a problem exists.

That is, for example, when a company does not have the right information on time, it produces can not make the right decisions or prevent mishaps, since what is desired (target) is to have all the information possible and have is uncertainty (results).

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[1] Trujillo, Carlos. Análisis de sistemas. Mimeografiando. Universidad del Valle Colombia.
[2] Johansen B., Oscar. Introducción a la teoría general de sistemas. Limusa. México. P 32
[3] Ackoff, 1998

## First approach: modeling from reality

This ***approach to solve problems***, describes a technique that involves the following steps: Identify the problem, decision to resolve the problem, Models of Reality, Use and work with the model and guidelines for action, decision, Commissioning, Operation and evaluation.

***Problem identification stage***

At this stage, which is seeking System objectives are not being met, making it clearly highlighting the magnitude and characteristics.

For example: In a grocery store a client requests a certain amount of merchandise which after having paid the shopkeeper realizes that there is no stock. The problem here is that there is no inventory control of merchandise.

***Decision to resolve the problema stage***

At this stage is performed feasibility analysis and decide whether "worth it" to solve the problem. To make the decision to solve the problem is necessary to conduct a feasibility study, which may cover several aspects such as:

- **Economical.** The question is if you have the resources necessary to fund the solution of the problem.
- **Technology.** It considers whether the technology exists to help solve the problem.
- **Operational.** It is important to know whether the proposed solution is applicable, used and accepted.
- **Motivation to solve the problem.** It is vital the actual arrangement to solve the problem.

In the event that one of these aspects is not feasible, you should not consider starting the process of solving the problem.

***Models of Reality stage***

The central idea of this stage is to model the behavior of the problem itself, guiding the knowledge of the situation and determine the overall objectives. Also, make the description of the system, identifying its supesystem, its subsystems, hierarchy and relationships.

***Use and work with the model and guidelines for action stage***

The model created in the previous stage is used for options of operation, to be able to define alternative solutions and evaluating them.

***Decision stage***

At this stage a group of people deal with the actions to follow. The decision may be to accept the proposals given by the study.

***Commissioning stage***

Is to plan and organize all the activities and tasks under the proposal accepted in the previous stage.

***Operation and evaluation stage***

This step ensures that the system works or operate regularly. In addition, it verifies compliance with the stated objectives through indicators.

## Second approach: creativity and constraints

In modern life, a professional in the area of General Systems Theory, must possess an essential feature that allows you to overcome obstacles and do not be average. This feature is creativity. Many authors argue that creativity is innate and therefore can not be taught or learned. The truth is that every person is born with some degree of creativity that must be developed with proper training from an early age.

Because oddly enough, the creativity of a person is mutilated by the type of education they receive from an early age, where, are taught to students to "think" in accordance with the guidelines of the school, family, country, etc thus suppressing the impulses born creative. By limiting creativity, ensures that institutions and models do not collapse. Thus, the wrongs of humanity are justified to maintain concepts that are the base of the institutions.

In his time, Galileo developed through research, mathematical modeling and observation, the theory that the earth revolved around the sun, it contradicted the arguments "accepted" at that time. Galileo used his creativity and solved a problem in way differently and correctly. Agree at that Galileo was right was to sow distrust of the believers who lead to the establishment of the disaster.

We thought then that if the children at an early age causes them to analyze and question the institutions, dogmas and paradigms, it is certain that revolutionary changes, innovative and useful they would more often when children they are older.It is also true that one way of doing things stops creativity.

For example, a math teacher puts on a review exercise that can be done in 5 different ways, but calls that are carried out by the method he knows. Truth be told, this teacher is teaching only knowledge that it dominates, moreover, does not allow students to develop other ways to solve the exercise, limiting possible learning first, and second, refusing to learn it from their students.

On the other hand, when we meet a group of friends and they say a riddle to solve, many, if we did not know before, we can not solve. This is the result that there is a self-imposed restriction, for example, has the following riddle: How would take a gold ring in a cup of coffee using just one hand, that the ring comes out clean.

In fact, the responses of the group of friends went from silly to ridiculous. All revolved around how to evaporate the water for coffee. The truth is that the solution to the problem was simply to get the ring with one hand full cup of coffee, because coffee is a solid and therefore can not get wet. The self-restriction placed friends restricted their creativity but this was so easy to apply.

We conclude that creativity is limited by self-imposed restrictions; therefore, to "get" Creativity should develop an ability to identify self-imposed restrictions and eliminate them. Clearly, to creatively solve problems is not sufficient to identify the self-imposed restrictions need a stronger boost.

# *FOUNDATIONS OF SYSTEMS*

Chapter

2

## BASIC DEFINITIONS

### Definition of Energy

***Energy*** is defined as material resources, financial, human and information that is transformed by a system to try to achieve their goals. For example, the furniture factory making wood (energy) and transforms it into chairs (energy produced).

The term energy was not taken arbitrarily to designate the inputs that are imported and exported products of super-Systems. The reason is that these energies meet ***Universal Law of Conservation***, ie the amount of energy that belongs to the system is equal to the amount imported minus the amount of exported energy.

But there is an energy that does not comply with the Universal Law of Conservation: This is the ***information***. That is, the information pertaining to a system is the difference between information entering and leaving, if this happens to teach my class General Systems Theory, the knowledge they impart to my students would necessarily have to forget, and in fact what happens is quite the opposite. To impart my knowledge, my students "store" this information, and I them, I can get more information, thus increasing my knowledge.

The great importance of the information in the General System Theory is this peculiar behavior which entitled the ***Law of the increases***[1], which holds that the amount of information pertaining to the system is equal to the information that already exists, more information incoming, from there concluded that a system never deletes information. Therefore we can conclude that this is the reason you can not study the systems with the reductionist theory.

### Definition of system

In the previous chapter system was defined as the set of parts that interact to achieve a goal, now, nourish this definition:

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[1] Ibid

***A System is a set of subsystems (smaller systems) that exchange energy to transform it (achieve a goal).***

Consider the Family system. Which among other parties is made up of parents and children, which in turn are also independent systems. In addition, any phenomenon is considered as a system when its constituent parts interact with each other and each are also systems.

For Javier Aracil[1], a system is a set of related parties functionally interdependent, which considered mainly interested in global behavior.

## Definition of Mega-system

Is defined as ***Mega-System*** or ***Universal-System***, the system that contains all the systems in the universe. In simple words, all systems known to man, created and unknown, that are interacting with each other to form this great system of reference.

## Definition of Super-System

The ***super-system***, a system of study corresponds to that system consists of all systems with which it is related that belong to Mega-system. For example, in the super system of a computer program would include the users, the computer, operating system, etc. The Super-System is the Union of all systems of the mega-system containing it. That is, every system which is part is included in the Super-System.

To identify the Super-System of a system takes into account all the systems with which it interacts. As each system is related to different systems of Mega-system for each system there will be a Super-System different, therefore each is unique Super-System. In addition, the Super-System can change over time, enough for the system to stop or start to relate to some other system to be modified.

Although the Super-System is unique and mutant, all have the same basic features of the systems (discussed below) that make it applicable General Systems Theory.

## Definition of SubSystem

***Subsystem*** is defined as all those systems that make up the whole (or system) of study. The subsystems are classified according to the importance of the relationship with the aim of study, relevant and not relevant. The first, called ***subsystem-Own***, are actively involved in achieving the objectives of the system, and the latter are treated simply as constituent parts. It is somewhat difficult

[1] Aracil, 1996

to determine if part of a system is a subsystem owned, so we suggest verifying the performance of any of the following rules[1]:

- **The Production Function.** That is to transform energy or provide a service. Presents an objective related to technical efficiency.
- **Support Functions.** Which would provide raw material for processing. For example, the departments of Public Relations and Marketing company
- **Maintenance Functions.** Its aim is to keep the parts of the system within it.
- **Functions of adaptation**. Its aim is to make the necessary changes so that the system can survive in the environment. For example, feasibility studies, reengineering, total quality processes, loss control, market research, etc.
- **Functions of Management.** That is to coordinate and plan activities and processes of the remaining subsystems also makes decisions

## ELEMENTS OF A SYSTEM

***Elements of a system*** are all the relevant characteristics that help to better analyze a system under study. The most important elements of a system are[2]:

- Objectives
- Synergy
- Recursion
- The input currents (Inflows)
- The process of conversion.
- The output currents (outflows)
- The provision of feedback (Control Element)
- Frontiers
- Environment

## Objectives

***The objectives of a system*** are the reasons why it exists. Without goals there is no system. All systems have objectives that are to transform energy, and only differ in "what" that transform energy.

In fact, we consider that the generic objective of a system is to transform energy in others. For example, an information system transforms the data (energy) in the information for decision-making (power transformer), while an iron transforms electric current (energy) into heat (energy Transformed).

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[1] Johansen, 1996
[2] To confront with Ibid

Bearing in mind that any system generates a transformed energy or product, the objectives represent the ideal product that any system must generate. Systems may have general and specific objectives, wherein the specific binding of the general form.

## Synergy

***Synergy*** is called the set of relationships or interactions between parts of a system. Similarly, Synergy is the energy exchange between multiple systems. She describes the way energy is transformed subsystems to meet the objectives. Synergy describes and determines the presence of relationships between constituent parts of a system.

The fundamental concept of synergy lies in differentiating the sum of its parts (subsystems) of the whole (system). For example, if we placed a container with a certain amount of water, carbon, iron and other substances that make up the human system, this mix is not out walking or even performing activities of mankind.

In fact, two or more systems may be comprised of the same parts and yet be different through synergy. A case of this situation is to compare a human being with a dog, obviously saving measures and ratios, the two systems have the same organic compounds and yet are completely different systems, the discrepancy is that the constituent parts are related (exchange energy) differently.

Another case that represents the importance of this synergy is: Two companies dedicated to building software, which have the same organizational structure and personnel, but we see that one has better results than the other and that's because the reference levels Synergy organizational, so a proper synergy causes better results. We conclude that the synergy, it represents the organization of systems.

Finally, by not being able to explain a system (which has synergy) from the analysis of one of its constituent elements, is inapplicable here reductionist theory, there lies the usefulness of the GST, because it provides the method that helps understanding the system studied.

## Recursion

***Recursion*** is called to the property that have the systems to be composed of elements (subsystems) that are themselves, behave and are studied as systems. Recursions provides subsystems for the characteristic of being separate elements, but in turn inherit the properties and principles applicable to the Systems.

Finally, recursion in systems expressing degrees of complexity and hierarchy. Thus, the human being is, among other parties, the human central nervous system, which in turn appears as the Sub-System Neurons are also systems.

*Consequently, we can again define the systems as a set of parts that have the features of Synergy and Recursion.*

## The input currents - Inflows

***The input currents***[1] are all energies that are imported from the Super-System. The input currents are the inputs or raw materials that the system needs to fulfill its objectives.

The energies that shape the input currents are the products of systems in the Super-system which relates the system being studied. On the other hand, the systems receive, through the input currents, the energy necessary and proper super-system, essential to its operation. ***Figure 1*** describes the input currents of a system.

The extreme dependence of a system to input currents generates major constraints and in some cases, when there is energy shortage is threatening their livelihood. This is why there are some systems that persistently fight for greater access and control over their energy sources.An example would the plants, which, when deprived of sunlight (placed under the shade of a building) can extend its branches until the leaves can access it, and they do because without it could not perform their basic tasks.

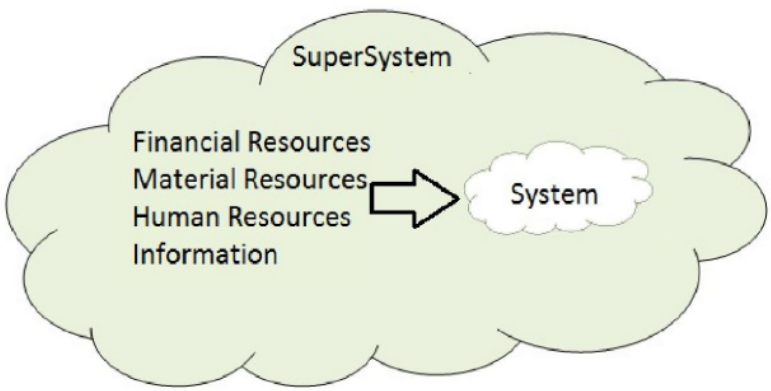


**Figure 1. The input currents**

[1] Confront with Ibid, Churchman, 1973 and Latorre, 1996

## The conversion process

The energy supplied from the super-system through the input currents are transformed so that the system can achieve its objectives. **Figure 2** describes the conversion process. Every subsystem of a system transforms the energy that is provided; this will be called **partial conversion** of the energy. In the end, these conversions will be transformed by partial special subsystems to refine and complete the conversion of imported energy.

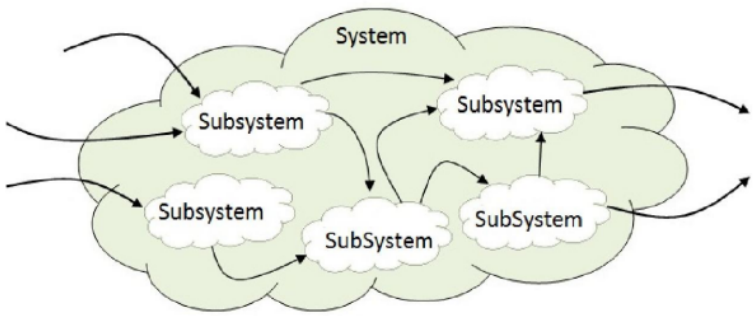


**Figure 2. The Conversion process**

## The Output currents - Outflows

The ***output currents*** corresponding to the products or processed energy, which the system under study exported to Super-System. The output currents are composed of a series of transformed energy, which are classified as ***positive*** because they are useful to the Super-System, or ***negative*** because they are not useful. **Figure 3** describes the output currents.Output current "smoke" is positive, but for those who do not smoke constitutes a fact or negative stimulus. With the above, we can say that the output currents of a system are evaluated by others belonging to the super-systems, in many cases from the perspective of their particular interests at the expense of their own legalization.

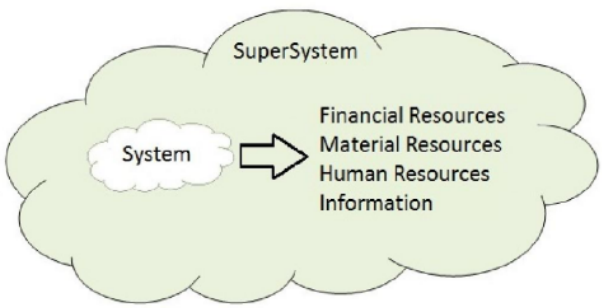


**Figure 3. The output currents**

## Feedback communication - The provision of feedback

***Feedback Communication*** is the information that enters the system that allows us to see if the system is meeting its objectives. This information is obtained using a procedure that involves comparing the output current with standards that quantify the objectives of the system, further indicates the difference found corrective actions to be performed. **Figure 4** describes the Feedback Communication.

It is noted that the Feedback Communication is ***information***, based on the analysis of output currents, which is introduced into the system to make the necessary adjustments to meet objectives. There are two types of feedback: Positive, when adjustments reinforce the momentum, and negative, that attenuated the initial effort. Positive feedback is used when the objectives of the system tend to infinity (+ or -). In contrast, the negative feedback is used when the objectives of the system are accurate.

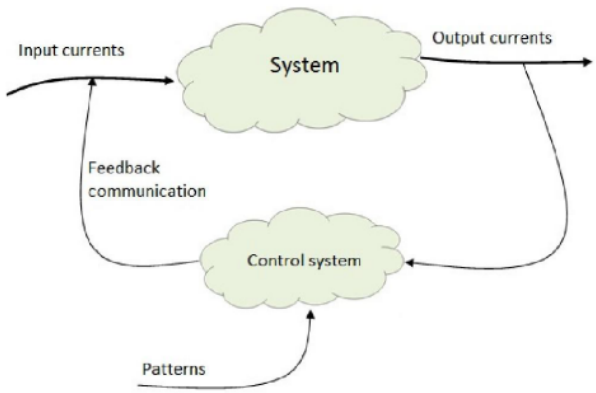


**Figure 4. FeedBack communication**

## Frontiers of the system

The ***Frontiers of the system*** defines what the systems of the Super-System belong to and what not. The Frontiers also define the structure of the system. There are 2 types Frontiers: Physics Frontier and Functional Frontier.

The ***Physics Frontier*** is one that defines a geographical area or space in which the system interacts. For example, the limits of a city and human skin.

The ***Functional Frontier*** expresses the limits in relation to the activities. For example, a Road Transport Company issued tickets and turns in their vehicles, but not men's clothing design.

## Environment System

The ***environment of a system*** containing all the parts and systems of the Super-System outside the studio system. Generally, the environment affects the system and the changes that occur in it, determine the behavior of the system significantly. The definition and identification of its environment is linked with the objective of the system, and point of reference for people who study it. **Figure 5** illustrates graphically the concept of a environment system.

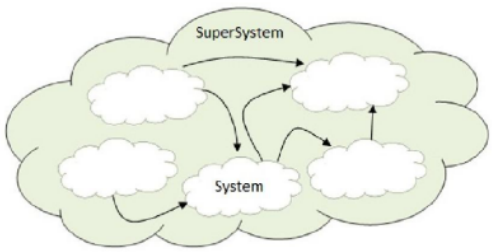


**Figure 5. Environment system**

***Active environment***

The ***Active environment*** of a system what are all the systems belonging to the super-system, that provide energy. That is, are all systems that relate to the system through its input current.

***Passive environment***

The ***Passive Environment*** of a system are all systems belonging to the super-system which they import energy flows out of the system. Figure 6 describes the two types of environment that has System

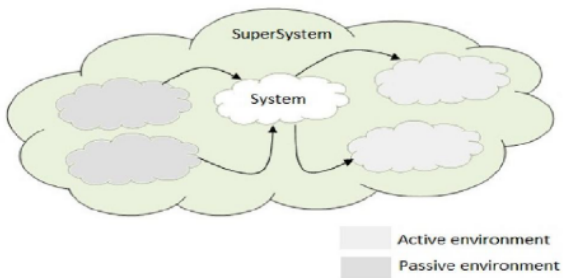


**Figure 6. Types of Environment**

## LEVELS OF ORGANIZATION OF SYSTEMS

Based on the concept of Synergy's own systems, we present the idea of organization structure Subsystem - System - Super-system. In fact, when you move from one subsystem to a system as an object of study has shifted to a higher level of organization and in turn, going from one system to a

super-system, has moved to a much higher level of organization in relation to the subsystem. When it delves into an object of study, from a subsystem to a system and then to a super-system, the complexity of the object of study is more, as well as understanding their behavior[1].

Moving in a manner contrary to (reductionist approach)

**Super-system -> System -> Subsystem**

The whole is less information.

Figure 7 describes the relationship understanding, complexity, organization of the whole advance in the study vs. a super-system to a system and then to a subsystem:

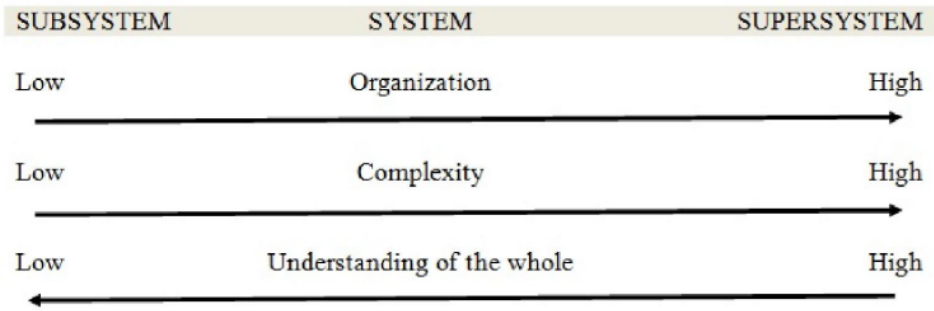


**Figure 7. Organization Subsystem, System and Super-System**

## ENTROPY IN THE SYSTEMS

### Entropy

***Entropy*** is defined as the energy that go into a system will cause a continuous organizational change, reflected in passing from a more organized with a less organized, or what is the same, go slowly, to a less likely ( organization) to its most likely in nature (chaos). Clearly, if we for a long time a solitary house when we visit again, we would find it "falling", or at least leave in the open a number of bricks, over time we see that they are apart. This is the manifestation of the entropy leads to its organizational systems more likely: The complete disorganization.

All energy that matters the system, to make you into its constituent parts or in their relations, chaos and misinformation is considered Entropy. For example, a person who daily breakfast coffee with rum,

[1] Confrontar con lo expuesto en Churchman, 1973

there will come a time when this disease of the liver and central nervous system, as the rum and coffee are entropy and these are generators of clutter and disorganization. Entropy gives rise to diseases of the system and brings them to death. It is no secret that the best way to destroy a system is disorganized.

The Entropy has as function the one to destroy to the System and for that reason is our greater preoccupation. Thus, the system Human Being, presents throughout its life a physical deterioration, and organizational decline that at some time will take to the death.

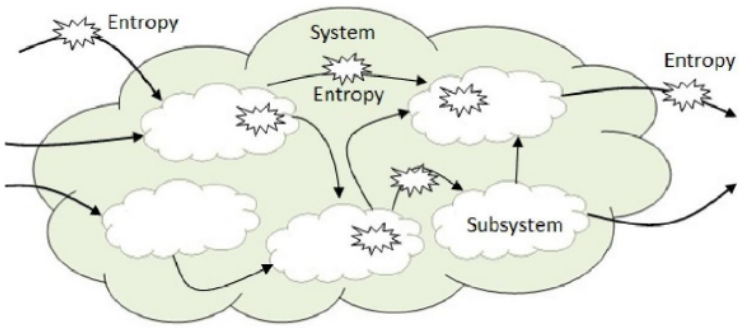


**Figure 8. The Entropy in the Systems**

The diseases that we presented the human beings are product of the Entropy that is accumulated in us. The Entropy produces a Cancer that mine little by little to the Systems, and most serious it is than this "disease" or tendency to the distortion presents all the Systems.

The chaotic effects and of disorganization that produces the Entropy are cumulative, beginning in a level of 0% when being born and the 100% when dying. The death of a System catalogues like the ***Maximum Level of Entropy*** and the birth like its minimum level.

It is necessary to consider that the Entropy always tries, no matter how hard we want to avoid it, to disorganize, to disinform and to create chaos in the Systems. It is for that reason that always is due to consider when we analyzed to a System.

## Negative Entropy

The ***Negative Entropy*** is the energy that when entering a system foments the improvement of the organization of its constituent parts, attacking the disinformation and the chaos. The main function of the Negative Entropy is the one to maintain low levels of Entropy in the systems, in this way "extends" the existence to him. Although it is impossible to completely eliminate the effects of the Entropy, the idea to maintain levels low of Entropy assures that the system operates to a 99%.

As well as the Entropy is the energy in charge to destroy the systems, the Negative Entropy is the energy that makes the birth possible of the systems. When dying a system, that is to say, their constituent subsystems no longer interact in search of an objective, in a time not infinitely, is created what ***AntiSystem*** is denominated.

This AntiSystem is conformed by Sub AntiSystems until certain hierarchic level, of there downwards, the Sub AntiSystems are formed by subsystems able to interact with other subsystems pertaining to Super-System being in freedom to form new Systems

On the other hand, we know that at some level of Entropy and its effects it will be always in the Systems. A system resists that it with the Negative Entropy, will be to him helpful for achieving its objectives. The energies that have organizing functions, of order and to inform are Negative Entropy, that prevents "the premature" death of any System. The function To inform inherent in the Negative Entropy makes think us that the Information is a "flowing source" of this type of Energy, but is necessary to consider that "to inform too much" can generate Entropy.

With base in the exposed thing previously, if one analyzes the characteristics of the Information, one concludes that it is an energy that looks for in its essence the order and the organization. For that reason the mathematical equality between the Negative Entropy and the Information is deduced.

## Entropy levels at the input

As much the Entropy as the Negative Entropy is introduced to the Systems through the constituent energies of the Input Currents, and it as well sends them to the system to its Super-System through the Output Currents.

In the Input Currents, there is a percentage of Entropy and another one of Negative Entropy, both adds the 100%. The minimum percentage of entropy that enters a System, never is zero, since all energy by natural law takes a desorganizador element, for that reason this minimum level is very near zero but never he is zero.

On the other hand, the maximum percentage of Entropy that enters a System naturally is the 100%. In order to describe the interval of levels a percentage scale will be used by comfort positive whole, from which tenth that the interval that represents the Amount of Entropy that enters a system is [1%-100%]. Starting off of the previous interval we concluded that the interval that represents the amount of Negative Entropy that enters a system is [0%-99%]

# SYSTEM'S ADMINISTRATION

## Process of identifying the objectives of a system

Previously it was defined what they were the Objectives of the System, now, analyzes a methodology for its correct identification. It is not easy to determine what is the objective of a System, since a standard methodology does not exist to identify them. But, the following one is suggested:

It is selected, first of all, a range of possible objectives that would fulfill the system to which we analyzed, remembering the energies of the exhaust streams. This range of objectives we will call ***Objectives Candidates***.

Secondly, they are taken one by one, the Objectives Candidates, and it is analyzed if the system sacrifices the others to fulfill this objective, in positive case, this candidate is an objective of the system.[1] For example, a Countable Information system were defined the following Objectives Candidates:

- Connection to Internet
- To lend support of access to the disc
- To maintain the accounting to the day.
- To send reports to the Suppliers.

It is clear that the system would sacrifice all the other Objectives Candidates to "maintain the Accounting to the day"

The Objective of a System represents sumatoria of the objectives of the subsystems conform that it. In fact, the methodology explained here is valid for all system including from the MegaSistema, happening through Super-System and the subsystems.

## Process of system management

The ***process of system management*** is in charge to level Macro to verify the fulfillment of the objectives of the System; And at Micro level to verify and to make pursuit of the fulfillment of the objectives of each one of the subsystems of the System, with the purpose of to apply corrective the necessary ones when and where it is necessary. These functions are reserved to special subsystems that we will denominate ***subsystems of Administration.***

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[1] Latorre, 1996

The subsystems of Administration are the ones in charge to define the objectives of the other subsystems, as well as to provide resources, to organize and to control the behaviors of the system. An example of typical Subsystem of Administration is the Subsystem Brain in the System Human Being. Other functions of the subsystems of Administration are: the generation of plans, use of the resources, control of the profit of individual missions and total, and the legalization of the system.

## Self-learning

A System presents ***Self-learning*** when the subsystems of Administration are able to generate changes in the form as the tasks are realised with the purpose of to adapt their surroundings better, based on the happened experience.

A Software of artificial intelligence generates changes of "conduct" at the most is its use. For example, an Intelligent Software of Security often is proven with real delinquents in order that self-learns from real confrontations with human opponents.

## Self-organization

A System presents ***self-Organization*** when the subsystems of Administration are able to modify the structure of the organization in progressive form, with the purpose of to obtain its objectives. For example, is said that the System Factory of Shoes self-Organizes when it implements in his operation quality controls.

## Legalization of the system

The ***Legalization of a System*** is the "Visa" that allows him to import and to export energy to Super-System. All System owns a ***Level of Legalization*** which influences in the amount and type of energy can import and export to Super-System.

The Legalization of the System is its life in Super-System. The low levels of Legalization indicate that the system does not own the capacity or is not allowed him to concern the suitable energies to achieve their objectives, which represents their progressive degeneration.

A typical case of the legalization, is a Software "x" that is not friendly for the user. The engineer of Software resists to modify it, arguing reasons that he creates advisable. Consequently the people who would have to use it not do it, of there, the data that do not introduce themselves, they are not process and in the long run the lack of use finishes with the "life" Software "x".

In order to increase the Level of Legalization, a System must use its administration to modify its structure, that is to say, its administration must foment, direct and to verify the self-organization, in

addition, must create and to apply its normalization of processes to arrive at a self-Control, additionally must generate the sufficient freedom in Super-Sistema like owning autonomy.

The Level of Legalization of a System considers like the degree of relation and interaction with its Super-System, which takes to us to determine that the Level of Legalization is not more than the degree Synergy of the System in relation to its Super-System.

## CONTROL SYSTEMS

All System must watch the fulfillment of its objectives, for these is important to develop the capacity of adaptation in its Super-Sistema. In order to adapt, a system must audit its "conduct" in relation to the own exigencies of the Systems that interact with him.[1]

What here we called conduct of the system is not more than to produce what Super-Sistema needs that it produces. One is due to consider that all system belongs to a greater system, than as well, needs that all systems suitably turn the provided energy.

Like example, an educative institution is had in which it is tried to foment the value of the ethics and the moral; all the educational ones that belongs to her must educate with the example, behaving with adapted ethical and moral when distributing their classes.

In the process of Control, the systems must be reinformar comparing their objective with the produced thing, and realise the adjustments necessary with the purpose of to reduce to the maximum the difference to reasonable terms.

## Indices of control systems

In the control of a system it is necessary to have parameters that they indicate at a certain moment if the system is fulfilling its mission, for that reason describe three (3) indicatives, that we denominated the EEE: ***Effectiveness***, ***Effectiveness*** and ***Efficiency***.

The ***Effectiveness*** of a System measures the profit of its specific Objectives. That is to say, the Effectiveness measures the difference between the product of the system with its specific objectives, between major is this less effective difference is the system. If we analyzed the System Warehouse of Shoes, presents a specific objective to sell per month a volume of 40% of the inventory and it only sells 5%, we found that this System is not Effective. But, if on the contrary the volume of sale is of 37%, necessarily we concluded that the system is Effective.

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[1] To confront the exposed thing with Johansen, 1996

The ***Efficacy*** of a System measures the profit of its General missions. That is to say, the Effectiveness measures the difference between the product of the system with its general missions, between major is this less effective difference is the system. If we analyzed again, the System Warehouse of Shoes, presents a general mission to increase the sales in a 50% and it only obtains 1%, we found that this System is not effectual. If the increase is closely together or is superior to 50% definitively he is efficacious.

The ***Efficiency*** of a System measures the profit of its Objectives considering that resources and that Costs were used to obtain it. The idea is to achieve the objectives on the basis of the minimum costs or in their defect in "Reasonable Costs". When we analyzed system that obtains his objectives using great amount of his resources, this it is very struck and vulnerable, which influences that it does not continue operating suitably, we concluded immediately that it is not an efficient system.

## Feedback and control systems

With the Negative Feedback, the Systems tend to remain in balance. This characteristic is propitious to carry out an suitable control of the Systems. With the Positive Feedback the control is impossible; since the parameters change continuously, in addition, always lies down to eliminate the effects of all planning.

Thus, a student who in his first note obtains a qualification of 4,0 on 5,0, like this one is major that the required minimum note (3.0), then would be placed as a note puts obtaining, for the next examination, of 2,0 how minimum. Nevertheless, the student does not study much and in his second examination she obtains a qualification of 1.0. Then, now its goal is to obtain a qualification of 4,0 to gain the matter. It is observed in this case, that the objectives always changes as it realises a new examination, takes it to a disinformation, besides a total uncontrol. With the Negative Feedback the same student would determine an objective to obtain how minimum a qualification of 4,0 in each examination, and if obtains more or less, its study always would have a same level of learning. We find in this case a smaller variation of the interest level and study of the student.

## Subsystems of Control

The ***Subsystems of Control***[1], are the parts of the system that are in charge to control to the system. The parts that constitute a Subsystem of Control are:

- Objective to control
- Subsystems of Sensitivity
- Subsystems Motors

[1] Ibid

- Resources of Energy
- Channel of Feedback

***Objective to control***

The ***Objective to control***, as to his it indicates it name, is one of the objectives of the system that needs control. It applies the studied thing, referring to the objectives identification.

***Subsystems of Sensitivity***

The ***Subsystems of Sensitivity*** are the ones in charge, first of all, to measure the changes provoked in the product of the system, and in second term, to realise the comparison with the patterns.

***Motors Subsystems***

The ***Motors Subsystems*** are the subsystems in charge to plan, to manage and to process the remedial actions.

***Resources of Energy***

The ***Resources of Energy*** are all those energies that need to be imported by the Motors subsystems to realise the pertinent corrections.

***Channel of Feedback***

The Channel of Feedback is the communication process between the subsystems of Sensitivity and the Motors subsystems, which transport the corrective information.

***Example:*** We consider the System conformed by Man - Radio and analyze a possible Subsystem of Control.

**Solution**

- ***Objective to control***. Quality of the sound that produces the radio. Which can be product of a bad tuning of a transmitter, statics (there is no a transmitter in the "dial"), damage in the radio.
- ***Subsystems of Sensitivity***. It is the auditory System of the human being.
- ***Motors subsystems***. In all the cases the average motors are the Muscular System of the human being, and in the case of the repairs by damages, the own tools radio technician.
- ***Resources of Energy***. They are the natural sources of locomotion of the human being, electrical energy, batteries, etc.
- ***Channel Feedback***. The communication channel is the air, using concretely its characteristic of propagation of the sound.

***Example:*** Now, the System is considered Thermostat and we studied a possible Subsystem of Control.