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ORIGIN, DEVELOPMENT AND CURRENT STATUS OF THE SYSTEMS APPROACH PARADIGM

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Abstract **-** The objective of this paper is to provide the general aspects of the meaning of the Systems Approach, as well as its development, origins and current status in Mexico, in addition to the description of some concepts used in the study of systems and their properties, landing on the systems thinking approach, framing the concepts of the system within a system and its properties, taking as a reference the contributions of different authors dedicated to the study of systems.

Keywords- Paradigm, System, Systems Approach, Systems Thinking, Systems Approach Paradigm.

DEFINITION OF PARADIGMS

Paradigm

The Real Academia de la Legua Española, defines the word paradigm as an example or model that is taken as a reference or as a point of comparison, this defines rules or regulations that provide beliefs and that its application can provide us with limits of interpretation of reality or in a given case provides us with a set of theories within a context that follow a model.

Paradigms", has been a term that is closely related to "normal science" (Kuhn, 1970), as a model or pattern accepted by the scientific community that groups together the concepts and theories accepted by a group of scientists that allows them to use a set of norms, values and rules in their routine tasks within a theoretical framework.

However, the same event can sustain different paradigms, due to the perception of the scientific bases of the individuals, as an example Kuhn describes that a physicist and a chemist can see hydrogen as an atom or a molecule respectively, this due to their models acquired in their professional preparation.

Paradigms are constituted by general theoretical assumptions, laws and techniques for their application adopted by recognized members of the same scientific community, which for a certain period of time provide models for the solution of problems; these paradigms are the basis for the beginning of scientific preparation.

How does the paradigm work?

Paradigms exist within the different scientific communities, which are the basis of the methodology for model replication.

If science works to transform the world we live in, and paradigms support the arguments on which it is based, we can consider the relationship between the operational world and philosophy as bidirectional through the scientific method.

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In one sense philosophy describes with the paradigm the methodological basis that transforms the operative real world, and in the opposite sense, through a series of gradual changes of improvement in the technique the paradigm can be modified.

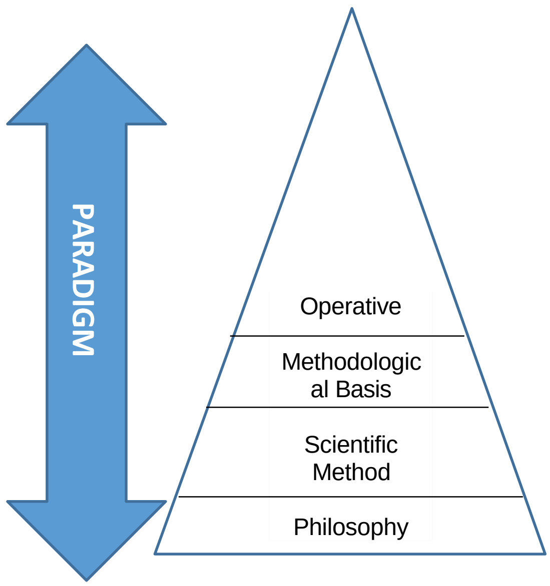

Figure 1. Relationship between the operational world and philosophy through the paradigm.

This bidirectional relationship can be described through a system. "A system is a set of two or more interrelated elements of any species" (Ackoff, 2002). In this case the elements are method, technique, processes and procedures.

This synthetic thinking is a paradigm.

Paradigm Breaking

At the moment that each researcher in his work deepens and increases the complexity in the theory and in the analysis he can find a diversity of new phenomena that are not explained with the traditional methods, this is described as a paradigm crisis, where it can only be solved with the establishment of a new paradigm, when these paradigmatic changes happen there is a scientific revolution, where a new paradigm is imposed.

Thus, when a paradigm changes, it can render the antecedent theories null and void, with the foretaste that what is impossible today may be the norm in the future.

METHODOLOGY

SYSTEM DEFINITION

What is a system?

A system is a set of structured and technologically organized tools for the achievement of objectives having a purpose within its environment.

We must start from the 3 general considerations of what a system is, which are:

a) which is a "whole" consisting of two or more parts, each of which can affect the performance or properties of the "whole",
b) that none of said two or more parts can have an independent effect on said "whole", and
c) that no subgroup of these two or more parts can have an effect independent of the "whole" (Ackoff, 1989).

System Properties

1. A system is a set of interrelated elements. It is composed of at least 2 elements related to each .
2. An abstract system is one in which its elements are concepts. In an abstract system, the elements are created by defining and the relations between them are created by assumptions (e.g. axioms and postulates). Such systems are the subject of study of the so-called "formal sciences".
3. A concrete system is where at least two of those elements are objects, this being the one of our interest. It establishes the existence and properties of the elements and the nature of the relationships between them, this requires an investigation with an empirical component. Such systems are the subject of study of the so-called 'non-formal sciences'.
4. The state of a system at a given time is the set of relevant properties that system has at that time. Any system has an unlimited number of properties. Those that are relevant

may change in the purpose of the research.

5. The environment of a system is a set of elements and their relevant properties where its elements are not part of the system, however, external elements can affect irrelevant properties of a system that are not part of its environment.
6. The state of the environment of a system is the set of its relevant properties at that time. The state of an element or subset of elements of a system or its environment can be similarly defined. The elements that make up a system's surroundings and environment can be conceptualized as systems when they become the focus of attention. Each system can be conceptualized as part of another larger system.
7. A closed system is one that has no environment, it is completely autonomous. An open system is one that does have an environment.

Systems may or may not change over time

8. A system (or environmental) event is a change in one or more structural properties of the system (or its environment) during a specified period of time; that is, a change in the structural state of the system (or environment).
9. A static system (a state) is one in which no events occur.
10. A dynamic (multi-state) system is one to which events occur, whose state changes over time. Such systems can be conceptualized as open or closed.
11. A homeostatic system is a static system whose elements and environment are dynamic. Therefore, a homeostatic system is one that preserves its state in a changing environment by internal adjustments.

System changes

12. A reaction of a system is an event of the system for which another event of the same system or its environment occurs. Therefore, a reaction is a system event that is deterministically caused by another event.
13. A response of a system is an event of the system for which another event of the same system or its environment, defined by a stimulus, occurs. Thus, the response is an event of which the system itself is a co-producer. A system does not have to respond to a stimulus, but it has to react to its cause.
14. An action of a system is an event of the system for which no change in the system's environment is necessary. Actions, acts, therefore, are self-determined events, autonomous changes.
    Internal changes: in the states of the elements of the system are both necessary and sufficient to cause an action. Systems whose changes are reactive, receptive or autonomous (active) can be called reactive, receptive or autonomous (active), respectively. Most systems exhibit combinations of these types of change. The classification of systems into reactive, receptive and autonomous is based on consideration of what causes the changes in them.
15. The behavior of a system is a system event that is necessary or sufficient for another event in that system or its environment. Thus, behavior is a system change that initiates other events. Reactions, responses, and actions can constitute behavior, being system events whose antecedents are of interest.

Behavioral classification of systems

16. A state-preserving system is one that can react in only one way to any external or internal event, but reacts differently to different external or internal events, these different reactions producing the same external or internal state.
    Such a system only reacts to changes; it is completely determined by the causing event. However, it can be said to have the function of maintaining the state it produces because it can produce a state in different ways under different conditions. A state-maintaining system can react to either external or internal changes. In general, most systems with 'statistics' (thermostats and humidistats) maintain the state.

A conservation system must be able to discriminate between different internal or external states to which it reacts to changes. These are necessarily adaptive, but unlike of goal-seeking systems, they are not able to learn because they cannot choose their behavior.

Table 1. Behavioral classification of systems

Behavioral classification of systems		
State Conservation	Variable but determined (reagent)	Fixed
Search for objectives	Variable and selected (sensitive)	Fixed
Search for multiple objectives and derivatives	Variable and selected	Variable but determined
Useful	Variable and selected	Variable and selected

17. A goal-seeking system is one that can respond differently to one or more different events either external or internal, in one or more states, and that can respond differently to a particular event in an immutable environment until it produces a particular state called a result. The production of this state is its goal, having a choice of behavior. The behavior of a goal-seeking system is responsive, but not reactive.
18. A process is a sequence of behavior that constitutes a system and has a production function objective. It is defined that each unit of behavior in the process brings the actor closer to its intended objective, thus resolving various situations and entanglements. Production processes are similar to a type of sequence whose objective is a particular product. The process behavior displayed by a system can be reactive, receptive or active.
19. A multiple goal seeking system is one that seeks goals in each of several different states whether external or internal, and that seeks different goals in at least two different states, the goal being determined by the initial state.
20. An intentional system is a system of pursuing multiple objectives for a particular, common product. The production of that common property is the purpose of the system. These types of system may pursue different objectives, but they do not select the target to pursue. The objective is determined by the initiating event. But such a system chooses the means by which to pursue its objectives.
21. A purposeful system is one that can produce the same result in different ways in the same or different states, whether external or internal, and can change its goals under constant conditions. Ideal seeking systems form an important subclass of useful systems, the differences between goals, objectives, and ideals and some concepts related to them should be considered.
22. The relative value of an outcome that is a member of a unique and exhaustive set of outcomes of a solved system is the probability that the system will produce that outcome when each of the outcome sets can be obtained with certainty. The relative value of an outcome can range from 0 to 10.
23. The objective of a solved system in a particular situation is an expected result that can be obtained within a specified period of time.
24. The objective of a solved system in a particular situation is the expected result that cannot be obtained within a specific period but can be obtained over a longer period of time. The pursuit of a goal requires the ability to change the objectives once the goal has been acquired. This is the reason why such a search is possible only for a purposeful system.
25. An ideal is a goal that cannot be obtained in a period of time, but can be approached without limit. Just as goals can be ordered with respect to objectives can be ordered with respect ideals, an ideal is a result that cannot be obtained in practice.
26. An ideal search system is a system useful for achieving whichever goal is closest to its ideal. An ideal search system is one that has a concept of "perfection" or the "desirable".

Relationships between systems and their elements

Some systems can show a greater variety and a higher level of behavior of any of its elements, this can be called increasing variety, when combining two or more elements.

elements of target search we can build a multilevel search.

Adaptation and learning

First, it is necessary to define function and efficiency.

27. The function of a system is to produce the results that define its objectives. To function, it is capable of producing the same result in different ways.
28. The efficiency of the system with respect to a result that has the function of producing, must go through an 'adaptation'.
29. A system is adaptive when there is a change in its environment and/or internal state that reduces its efficiency in the consecutive pursuit of one or more of its objectives that defines its function, it reacts or responds by changing its own state and/or its environment to increase its efficiency with respect to that objective or objectives. Therefore, adaptability is the ability of a system to modify itself or its environment when either has changed to the disadvantage of the system in order to recover at least some of its efficiency loss.

The definition of 'adaptive' implies four types of adaptation:

29.1. Other adaptation: The system reacts or responds to an external change by modifying the environment.

29.2. Another adaptation of the target itself: A system reacts or responds to an external change by modifying itself.

29.3. Self-other adaptation: A system reacts or responds to an internal change by modifying the environment.

29.4. Self-self adaptation: A system reacts or responds to an internal change by modifying itself. Self-adaptation of another type is more commonly considered.

29.5. To learn is to increase the efficiency of a system in the pursuit of a goal under unchanging conditions. Whereas, if a system is repeatedly subjected to the same environmental or internal change and increases its capacity to maintain its efficiency under this type of change, then it learns to adapt, thus adaptation itself can be learned.

Organizations

An organization is a useful system that contains at least two elements that have a common purpose.

We sometimes characterize a purely mechanical system as well organized, but we would not refer to it as an 'organization'.

System organization is an activity that can be carried out only by purposeful entities; being an organization of a system that must contain such entities.

An aggregation of purposeful entities does not constitute an organization unless they have at least one common goal: that is, unless there is one or more things they all want.

An organization is always organized around this common purpose. It is the relationships between what the purposeful elements do and the pursuit of their common purpose that gives unity and identity to their organization.

Without a common purpose, the elements would not work together unless they are obligated to do so.

An organization consists of elements that have and can exercise their own wills. Each of two or more subsets of elements contains one or more elements, which are responsible for choosing between different courses of action. A choice of each subset is necessary to obtain the common purpose.

Classes of courses of action and subsets of elements can be differentiated by a variety of types of characteristics; for example:

a) By function
b) For space
c) By time

Action classes can, of course, also be defined by combinations of these and other characteristics.

Functionally distinct subsets can respond to each other's behavior observation or communication.

Choices made by elements or subsets of an organization must be capable of influencing others, otherwise they would not even constitute a system. At least one subset of the system has a system control function. This subset compares the results achieved with the desired results and makes adjustments in the behavior of the system to which they are directed to reduce the observed deficiencies. It also determines what the desired results are. The control function is normally exercised by an executive body operating on a feedback principle.

30. An element or system controls another element or system if its behavior is necessary or sufficient for the subsequent behavior of the other element or system and the subsequent behavior is necessary or sufficient for the achievement of one or more of its objectives.

An 'organization' can be defined as:

31. A useful system that contains at least two elements that have a common purpose in that the system has a functional division of labor; its functionally distinct subsets can respond to each other's behavior through observation or communication; and at least one subset has a functional control system. Now the critical difference between organisms and organizations can be made explicit. While both are resolved systems, organisms do not contain elements. The elements of an organism may be state maintenance, goal pursuit, multilevel or intentional pursuit; but not purposeful.

Therefore, an organism must be of increasing variety. An organization can be of increasing variety or it can be of decreasing variety.

An organism is a system that has a functional division of labor, its functionally distinct parts are called 'organs'. Their functioning is necessary, but not sufficient for the of the organism's purposes.

The coincidence of different investigations requires that the sets of concepts used in them coincide. A scientific field can emerge only on the basis of a system of concepts. Systems thinking must be carried out systematically.

Systems science represents a new technology that has been called the second industrial revolution and has only been unfolding for a few decades.

It also seeks rules of general value that can be applied to all kinds of systems and with any degree of reality. It should be noted that systems consist of ordered modules of parts that are interrelated and interact with each other. A distinction can be made between a conceptual or ideal system based on an organized group of definitions, symbols and other tools linked to thought and a real one (a material entity with ordered components that interact in such a way that the properties of the whole cannot be completely deduced from the properties of the parts).

SYSTEMS APPROACH

Origin

Nowadays the term "system" is used in different ways by different people. For an engineer it can be a physical object. To an economist it can be a mode of operation such as a free market system or an inventory system. To a computer specialist it can mean the computer hardware system or the software programs of an information system (Chen, 1975).
The term "Systems Approach" appeared in the second half of the last century, and since then its use has been recurrent, with different meanings.

Systems approach in Mexico

In 1955, with the creation of the Institute of Engineering and the Division of Graduate Studies at UNAM, interest in operations studies began to emerge with the publication of three books:

- Morse Philip M. and George E. Kimball, Methods of Operations Research, MIT Press, Cambridge, 1951.
- McCloskey Joseph F. and Florence N. Trefethen (Eds.) Operations Research for

- Management; The Johns Hopkins Press Baltimore, 1954.
- Churchman C. West, Russell L. Ackoff, E. Leonard Arnoff, et al., Introduction to Operations Research, Wiley, N.Y., 1957.

Salvador Cardona, one of the main promoters of these studies with knowledge obtained from Dr. Arnold Kaufmann, considered to be one of the pioneers of mathematics applied to operations research.

Likewise, several engineers have contributed to promote the application of mathematics, computing, operations research and systems engineering in various public and private entities in the country, reinforcing production processes and strengthening human resources to make industrialized processes more efficient.

In 1966, Dr. Roger Díaz de Cossío and Dr. Juan Casillas García de León invited Dr. Russell L. Ackoff, one of the most important thinkers and implementers of the Systems movement, to formulate a training program for high-level professors in Operations Research at the University of Pennsylvania to meet the needs of the School and Institute of Engineering.

New structures and projects were created in Mexico, thanks to Dr. Ackoff's influence and thinking, as well as his collaboration in various research activities and the founding of several societies related to the study of systems in Mexico.

What is the Systems Approach?

The concepts and terms commonly used to talk about systems are not organized in a system. System and the most important types of systems are defined so that explicit differences and similarities are made.

Organizations are the ones that pay attention to scientists. The relationship between a system and its parts is considered and proposed as one of relative variety in terms of the behavior of its parts with different increase or decrease of this variety.

The system concept has come to play a critical role in contemporary science". This concern of scientists in general is reflected among management scientists in particular for whom the systems approach to problems is fundamental and for whom organizations, a special type of system, are the main subject of study.

The systemic approach to problems focuses on systems taken as a whole, not on parts. Such an approach refers to the performance of the total system even when there is a change in some of its parts, some properties of systems can only be adequately addressed from a holistic point of view. These properties are derived from the relationships between the parts of systems. Without having a concept, systems research is very scattered.

Churchman uses a fable about several blind men each touching a different part of an elephant to illustrate the system concept. The moral of the story is that when we face a problem we should not only look at one part of it, but instead look at the whole scenario which should be interpreted as the system concept (Chen, 1975).

How can we know that we are dealing with the whole problem and not just a part of it? The blind man and elephant syndrome is very evident when the problem becomes more and more complex (Chen, 1975).

Most problems, such as those involving social, economic and political behavior, elude such identification (Chen, 1975).
The important question is whether or not we have identified the correct problem (Chen, 1975).

Rudwick cites a case involving a problem in a new office building. Four elevators serve the building's forty floors. A few months after opening, complaints came to the superintendent's office about long wait times in the elevators at check-in time. This can be seen as a classic waiting line problem. To solve it, the automatic elevator control was first reset, which didn't change the situation much, so an operator was assigned to control the elevators at the time of entry. This was also unsatisfactory. Finally, the elevator manufacturer was called in to investigate the problem. After analyzing the situation, the manufacturing engineers suggested several solutions: One was to replace the existing control with a more complex one that offered features such as routing one elevator for direct travel and another with stops at each floor. Another alternative was to add a panoramic elevator to be installed outside the building, which would cost about $50,000. While the executives debated the pros and cons of these proposals, one person came up with an ingenious idea that solved the problem at a cost of only $300.

How was this possible? Very simple: a television was installed in the lobby of the building for the employees to watch a program while they waited for the elevator to return to the second floor. There were no more impatient people and the complaints ended (Chen, 1975).

The solution of a problem depends very much on how well it is defined at the beginning. In the case of the elevator it can be seen as a waiting line problem, or as a problem of boredom during the wait, which was much simpler to solve (Chen, 1975).

A problem can be defined as the difference between the desired state of affairs and their current state at a given point in time.

$$P_t = |D_t - A_t|$$

P_t= Problem at time t
D_t= Desired state of things at time t A_t = Current state at time t
t= A point in time

A problem $P_t > 0$ can exist if and only if any of the following conditions exist:

a) The state remains the same, but the desired state changes. Problem Type I
b) The desired state remains, but the current state changes. Problem Type II
c) Both the desired state and the current state have changed to different positions. Problem Type III

The systems approach to the Type I problem begins with the definition of a new desired state or goal. This helps to delineate what is a problem and what is not. Once the new desired state is defined, the process is simplified. One of the contributions that the systems makes in problem solving is this emphasis on techniques and methodologies to achieve system simplification.

The alternatives once generated should be evaluated according to the given criteria and the order of priorities.

The systems approach to the Type II problem assumes that the desired state exists and is well established; the problem is to diagnose the cause of the current state.

Various techniques and methods are available to detect certain types of symptoms.

DISCUSSION

SYSTEMS THINKING

Alternative views of a system

According to Ackoff, systems can be of three types: mechanical, organic, and social. The first refers to systems when viewed by their internal structure, whose functions are dictated by causal laws of nature. Among the relevant characteristics of mechanical systems is the fact that they serve purposes external to them, so that their constituent parts may have subfunctions.

On the other hand, organic systems are characterized by having a goal or purpose of their own, but their constituent parts do not have subfunctions of their own. Unlike mechanical systems that can be open or closed, organic systems are necessarily open systems, i.e., they are subject to external influences.

Finally, social systems can be considered as systems that have purposes of their own, at least some of their constituent parts have purposes of their own, and they are part of larger systems that have purposes of their own.

Taking into account the above, all entities can be seen as some of the previously described systems, in this sense, the following is the approach of a company considering the described systems (Ackoff, 1989).

The company as a machine

Throughout history companies have been managed from different approaches, at first with the Industrial Revolution, machines were created to do the work of humans, and with this same vision companies were created that were considered machines, which had no purpose of their own, but had to serve the purposes of their owners, "to provide them with a return on their investments by making a profit".

In this beginning, workers were considered as physical elements, such as parts of a machine, i.e., replaceable and almost without any social consideration (Ackoff, 1989).

The company as an organism

At the end of World War I, the vision of a company as a machine changed to the company as an organism. Among the most determining factors for this change was the fact that more capital was required, so they became public companies. Managers changed their thinking from considering profits as an end to considering them as means. This vision allowed them to consider profits as a means to *survive* and *grow*, and not as a goal. Companies began to be called "corporations" from the Latin *corpus*, which means body, and with this they were considered as biological individuals, also before the law, and even changed the name of the positions within the companies to names used in biology, as for example "head" was named to the executive directors.
With the rapid growth of technical advances, more and more advanced personnel were required, which began to change the consideration of workers as replaceable, and they began to consider them as important, like organs in an organism. This change also produced a new collective conscience, which began to demand better working conditions and a change in the approach that companies had had up to that time (Ackoff, 1989).

The company as a social system.

Due to the pressures exerted by workers' new awareness of their rights and worth, companies began to be considered as social systems, with all the characteristics that describe them. In this way

Relevant to these considerations it can be appreciated that: a system is a whole that cannot be divided into independent parts, its performance is never equal to the sum of the actions of its parts taken separately, but is a function of their interactions.

In this sense, it can be shown that when each part of a system, taken separately, is made to perform at best, the system as a whole cannot perform at its best (Sengupta and Ackoff, 1965).

Some consequences of a system being seen as a social system.

To begin with, a social system comprises a proper function, constituent parts with proper sub-function, and are parts of a larger system with a proper function. In order to have better management, a system can affect its parts in two ways, by increasing or decreasing the range of behavior that its parts can perform, the propositional behavior of these parts consists of choices of ends and means, so social systems must increase or decrease the range of choices of their parts. Autocratic social systems generally reduce the variety of permissible behavior of their parts, and a democratic social system increases this variety.

To understand social systemic functioning, we must study the interactions of its parts and of the whole with other systems with which it is part of larger systems.

An enterprise conceptualized as a machine is organized and managed to severely constrain the behavior of its parts, and its effectiveness depends on its constituent parts performing the same function in the same way, over and over and over again, this behavior can describe bureaucracies, which are conceived of as mechanical organizations.

A social system conceptualized as an organism will have more behavioral choices than if it were conceptualized as a machine, but this variety of choices does not affect the functioning of its parts, only the way it performs that functioning.

An enterprise conceptualized as a social system must serve the purpose of its parts and the system of which it is a part. It must enable its parts and the systems it contains to do things they could not otherwise do. This means that social systems must increase the variety of both means and ends available to its parts and to the systems of which they form a part.

It can be considered that, in a company, centralization reduces the variety of choices, and decentralization increases this variety (Ackoff, 1989).

Analytical versus synthetic administration

The managers effective manage the interactions within the part of the system for which they are responsible and the interactions of that part with others within or outside the organization that it affects and by which that system is affected. The predisposition to take things apart and treat those parts separately is a consequence of analytical thinking. In this sense, analysis, in order for something to be understood it must be separated, and its behavior understood in isolation, and to understand the whole the understanding obtained from each of the parts is added up. In contrast to this, synthesis is the opposite, and for its application certain steps have to be followed, which are: first, to understand , it has to be understood as part of a larger whole, so it is placed together with other parts, to analysis which would isolate the part; second, understanding of the larger system that contains that thing is required; third, the behavior and properties of that system are explained by revealing the role of thing or its function, in the larger system that contains it.

Therefore, the understanding of a system cannot be obtained by analysis, since it would only reveal its structure and how it works, so knowledge of how does so would be obtained, but not its understanding.

Relevantly, the distinction is made that a system is a whole whose essential properties are not shared by any of its parts. Therefore, if we consider its parts as parts of a whole, that is, its functions and roles in the whole, we can obtain its essential properties and explain its behavior (Ackoff, 1989).

From management to leadership

At the beginning of the industrial era, employees were not able to perform the job better than how their bosses performed it, therefore, there was supervision of subordinates by the bosses.

Today, the opposite is true; most workers can do their jobs better their bosses could. So the role of managers has changed, and it has three main functions: The first function involves creating an environment in which our subordinates can do the best that they know how to do, that is, to get the best results that a worker can give; The second function involves enabling workers to do better tomorrow, the most they could do today, so we must encourage the development of workers, understanding as "development" an increase in our ability and desire to satisfy our own legitimate needs and desires, and those of others; and finally, the third function of a manager is to manage 1) the interactions of those for whom and for whom they are responsible, 2) the interactions of their units with other units of the organization, and 3) the interactions of their organizations with other organizations in their environments (Ackoff, 1989).

Problems and messes

One of the most dangerous misconceptions in management is that problems are objects of direct experience; however, they are not. Problems are abstractions drawn from experience through analysis. Managers are not confronted with separate problems but with situations consisting of complex systems of strongly interacting "messes". Therefore, the behavior of a mess, which is a system, depends at least on the interactions of its parts and how they act independently of each other (Ackoff, 1989).

Ways of dealing with problems and "messes".

The following four ways of dealing with them in the real world are considered.

Absolution. It refers to ignoring them and hoping they will go away on their own.

Resolution. Performing some action that provides an output that is sufficiently good, and that it is satisfactory. It focuses more on the uniqueness of a problem or a "mess" than on its generality.

Solution. Doing something that results in the closest to the best option, i.e. that is optimal. It focuses more on the generality of the problem or "mess" than on its uniqueness.

Dissolution. This refers to redesigning the entire entity or environment containing the problem or mess, so that it is eliminated and allows the system involved to function better in the future than it can today, i.e. it idealizes it, and is based on both the generality and the uniqueness of the problem or mess (Ackoff, 1989).

Problems and disciplines

In a general way, it can be found that through the education received in schools, problems are considered to be within certain disciplinary categories, however, there is no such thing as a disciplinary problem. This has been done because knowledge has been divided into disciplinary fields. Disciplinary categories reveal nothing about the nature of the problems assigned to them, but they do tell us something about the nature of those who place them there.

The effect of categorizing problems by discipline is that they tend to be attacked only by people from that discipline.

The best way to approach a problem involves the collaboration of multiple points of view, a transdisciplinary point of view (Ackoff, 1989).

CONCLUSIONS

SYSTEMS APPROACH PARADIGM

Arriving at the terms

The whole idea of systems science refers to its organizing or active principles. In this sense, one can roughly consider the term *whole idea* with the term "Big idea", which being applied to system science corresponds to the "ordered integrity"- The term *main idea* refers in the present text to a set of central constructs or fundamental postulates that in the case of systems science essentially includes a "complete organization of parts, a unit, a whole, or system", i.e. an ordered wholeness, or an ordered complexity. Thus, it can be determined that the main idea of systems science is the principle of organization. Figure 2 shows the first order models (empirical sciences) and their relationship with general systems.

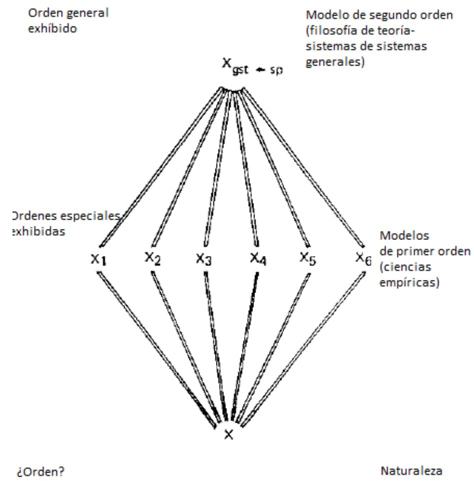

Figure 2. The scientific progression from the first-order models of the special sciences to the second-order models of general systems science. Ervin Lazlo, Introduction to a Philosophy of Systems, 1972.

The whole idea of systems science

General systems science has advanced to a higher level of scientific generalization or abstraction. This relationship between systems science and the special sciences-and the goal of systems to establish an integrative super-order-are well conveyed the following diagram, which shows the attempt by systems science to further generalize the generalizations of the special sciences-the induction of second-order models from models, to represent that all systems have something in common. "If an object is a system, it must have certain characteristics of general systems, regardless of whether it is of another kind" (Von Bertalanffy, 1968).

The whole idea of systems science is used to develop a scientific paradigm, superordinate to the special sciences, which can bring first-order models to higher-order syntheses. The comprehensive super-order provided by systems science could appear the form of their abstract representations that all systems have in common.

The main idea of systems science

A system can be considered as a "set of interacting elements" (Von Bertalanffy, 1968) so that the characteristics of the system cannot be understood in isolation.

Thus, the characteristic organization of a system is given in the general patterns or interrelationships of the whole that emerge from the existing interactions through its interdependent parts (cf. Germana, 1989).

Additionally, if the parts or element of a system are themselves taken as systems, i.e. subsystems, then the total system in question appears as "greater than" and "other than" the sum of its parts. To the extent that the organized complexity or system incorporates its parts into a new, different, emergent whole, a superordinate level of integration is represented.

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