APPROACH TO COMPLEX PROBLEM SOLVING ORIENTED TOWARD THE PRINCIPLES OF PROCESS

Cite

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Abstract: The methods, techniques, and classical approaches for the identification and characterization of a problem does not seem to neither please, nor fully answer the complex problems of contemporary society in a speedy manner. The complexity of today's problems requires the adoption of innovative tools, problem-centered rather than in effects or preconceived solutions. The human development is an entrepreneurial process by the comprising societies, and should be directed to the human being and its context. This scope emphasizes the notion of process, the complex, the trans disciplinary, as well as the use of strategic action research investigations. The purpose of the article converges to a type of social engineering aimed at defining strategic elements to form an approach directed at identifying the real problem. Known as "The Approach to Complex Problem Solving Oriented toward the Principles of Process", the proposal is based on existing theoretical framework of a problem and on the principles of the world view in the process, casting light on the problem and not the solution.

Keywords: complexity, problem-oriented approach, process design, transdisciplinarity

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1 Introduction

The development of humanity carries a problematic that has stood out as an emerging matter of debate between the public and private managers. Some of these issues get an immediate solution. However, a majority returns, with some frequency, to the agenda. The era in which we live is characterized by a great crisis of many theoretical models. There is consensus that the guiding world views from the past are insufficient to explain the present, and to anticipate the future. The now obsolete models from the past, may also influence the vision and condition it. The crisis, which De Masi (2000) prefers to call the general gloom, is not without harmful consequences for those who observe it. He asserts that when a nation or group perceives its decline, it ends up accelerating it, by losing its ability to chart, and to bring forth its own future.

The problems are inputs from the crisis, instability or imbalance, and asymmetries; moreover, they also stimulate the studies, opportunities and growth. The contemporary nature of the problem is very varied, from different orders and different genesis, since man establishes interface and is

related to many variables. To illustrate, only with regard to the relationship man-environment, the United Nations Environment Programme (UNEP) listed twelve big problems facing humanity.

The UNEP (2011) calls attention to the following issues: rapid population growth, accelerated urbanization, deforestation, marine, air and soil pollution, and eutrophication and contamination of inland waters, loss of genetic diversity, effects of large civil works; global climate change, gradual increase in energy needs and its environmental consequences; food production and agriculture, and lack of basic sanitation. The problems are recurring and exponential and the magnitude of environmental problems can be best understood when added to socioeconomic issues, political-cultural and their interrelationships. The efforts made so far do not seem to support effective solutions to the problems previously listed.

The dubious managerial capacity to identify and solve the world's complex contemporary problems feeds the following questions: Why not change the pragmatic approach of the problem identification given by the Industrial Society to the subjectivity required nowadays? The values, previously discarded, can now add value or make a difference for a correct, contextual and humanized identification of the contemporary problems?

Hegedus apud De Masi (2000) states that the core problem is science, and the profound transformation of the scientific method i.e., the transition from discovery to invention, the search for solutions to the search for questions. There is a revolution of the scientific method and the relationship with nature, characterized by the planning for the future through a new way of doing science; which relies on the information and is modeled by a method other than the industrial that formulate problems and proposes a solution without getting in advance entangled by their links. Conversely, transform the links in opportunities.

The problem can be analyzed according to their dependence or independence of the context. The complex problem, the object of interest of this approach, takes man and his relation to the context under consideration. The problem is not complex, in turn; it can be analyzed apart from reality, as a mechanical action, an automaton, a result from the sealed conditions of a laboratory, where they always reach the same result, irrespective of the contextual differences.

2 Problem

Many issues of the contemporary everyday life resulting from the anthropogenic action, the development model, still disturb the management and persist in awaiting answers. The problems relate to the questioning and encourage the investigative process, trying to get answers. Nowadays, the identification and characterization of a complex problem, as well as its proposed solution, demonstrate few concerns regarding the orientation to man and the context. Simon (1987) and Morin (1991) share the idea that the human being is not only a biological or a cultural being but also, by its nature he is multidimensional, and threefold. Being a member of society and an individual at the same time, man lives and shares the daily collective problems.

The Cartesian paradigm has led to a fragmentation of the knowledge and of the subject itself. Conversely, the complexity paradigm seeks to break away from the Cartesian paradigm. From the modernity there was a loss of the ability to formulate concepts in an integrated and objective manner, the unifying conception was also lost. Instead, it was created a fragmented moral pluralism that did not promote an orderly integrated dialogue according to the new requirements. The

methods, techniques and approaches found in the literature seldom consider the complexity, context, trans disciplinarity and man as a unit, variables that permeate the problems of contemporary society. The complex problem requires from the student a thorough research on the causes and consequences, avoiding hasty and erroneous solutions and aiming, above all, at a precise and correct identification and characterization of the problem.

Typically, a problem situation hides the list of reasons that led to the problem that built the pre-existing situation. The problem is always presented already formatted as an issue to be resolved. If not, the information provided are insufficient, leading the citizen or the student to walk through the existing situation without deepening, which has hindered the most important step in the conceptual analysis of the problem: the core of the situation- problem, the profile of the players involved and the objective structure of the events initiated (LEME, 2005).

2.1 Work motivation

The Cartesian method is indispensable to solve human problems that relate to the so-called exact sciences and technology. But it is insufficient to solve human problems endowed with certain subjectivity, such as trust or the entrepreneurial action in the process of regional development. To accept the paradigm of complexity is to accept the contradiction, the dialogical relations that are established in the order and disorder, in the harmony and disharmony.

It is true that for the problems identification and solution models co-evolve to the same extent that the problems change, they get old and new, instantly and simultaneously. When a problem becomes resistant to the old methods of identification, whether based on control or in solution, it causes more demotivating effects and creates a barrier to creativity, even when there is greater need for it, to stay active.

The identification of complex problems is seldom achieved by isolated actions: it demands the engagement of plural skills, of transdisciplinary teams. The scientific subject is a collective subject and knowledge is a social achievement, because it is not won by a wise man alone, but by a community (BACHELARD, 1996; GATTAZ SOBRINHO, 2001). The contemporary scientific knowledge distances itself from the common knowledge, while attempting to deal with a reality that cannot be addressed by human sensitivity.

The complexity of today's problems calls for synergistic solutions, focused on the inseparability of these processes, the scientific and technological collaboration, integration and interoperability of the institutions, for the development of cooperative networks. Man will be able to overcome the difficulties inherent in the scientific method of problem identification, when he is able, along with technology, to organize a democratic scientific method, with emphasis on the human being and oriented toward universal principles.

2.2 Hypothesis

At the core of knowledge is the concept that life is a process of problem solving. In this process man formulates hypotheses that he can never know if they are true or not. He is able to test (try to falsify) a theory, and confirm it repeatedly. This does not mean; however, that it is truthful. It is possible that at any given time someone else will formulate a new improved hypothesis regarding the same problem, or a new way of testing it, and prove that the theory is incorrect (POPPER, 1994).

The complexity inherent in the socio-economic processes, political-cultural and environmental, should be treated properly and with the required seriousness, since it reflects the behavior of the context. The vision of the complex shows the real problem; thus providing its solution. Exposing the complexity is, therefore, to work toward better definition of the problem. Science begins with the problems created by previous theories (POPPER, 1993). Observation is not science's starting point, rather the hypothesis is, that kind of intuition or illumination capable of creating a leap in quality.

The sharper the complexity, the more apparent is the problem; therefore, its solution (GATTAZ SOBRINHO, 2001). The theoretical-practical development compatible and recurring to complex contemporary problems, is conducted by a research strategy having as articulation basis a group of principles that can limit, and/or enhance the visualization, identification, and characterization of a problem. The principles are promptly collated with the phenomenology, in order to better discern the problem.

The identification of a problem with emphasis on man, and in his context can reduce deviations and conceptual errors, such as those models favoring the organizations and the structures. The context gives meaning to the content, and is based in the social life, the facts of daily living and the individual's familiarity with the environment or with a certain reality. Every context has a dimension of knowledge or information. Therefore, the context should be the main link between the problem and proposed solution.

According to Leme (2005), it is hard to notice the set of circumstances imperative to fully understanding the problem, and so necessary for a redirect, readjustment and reorganization of the events and people. The vision needed to realize the tangle of agents of a problem-situation is called: the vision beyond reach. It is the one that manifests itself when the unseen is to be seen. Only then, will the effects appear in the light of the causes. Only then will the track lead to the origin of the path. Invariably, it confuses the cause's spectrum with the effect's trail.

2.3 Objective

The objective of this work is to develop an approach to complex problem solving, from the viewpoint of problem recognition, not on the effects or the solution used to solve a problem. In subjacent form tries to validate the Method of Oriented Research Process (MPOP), according to Argollo Ferrão (2007, 2008), and to apply the Principles of Process and the PArchitect technological environment for modeling the problematic solving process, both proposed by Gattaz Sobrinho (2001).

Given the characteristics of the identified phenomenon; was chosen an exploratory, analytical and descriptive study, combined with document analysis, based on information contained in the literature, available in books and periodicals. The research is based on Richardson et al., (1999) which describes the exploratory method as the one that seeks to understand the characteristics of a phenomenon; to subsequently search for further explanations of the reasons and consequences of that phenomenon/problem.

3 Theoretical Referential

The clarification of the word problem fulfills a requirement of the investigative process. A current definition identifies the problem with the question, which gives rise to a series of misunderstandings, and misconceptions about the nature of both the real and the unreal ones. Another definition establishes the problem as something that causes imbalance, discomfort,

embarrassment to the people. However, within the scientific definition, a problem is any unresolved situation subjected to discussion in any field of knowledge.

Etymologically, the word problem stems from the Latin problēma, ătis, with the same meaning and adaptation from the Greek próblēma, atos, «salient, cable, promontory, cusp, what you have before you, obstacle, protection, armor, shelter, proposal, task, question, controversial issue, problem», and from 'probállō' «to throw, to signal, to accelerate, to drag, to put forth, to lunge, to start a fight, to throw in his face, to rebuke, to propose a question, an issue etc.,» (HOUAISS, 2008).

Michaelis (1998) conceptualizes the word problem as an issue raised for consideration, discussion, decision or solution. It is also an issue whose solution or resolution is difficult, what is difficult to explain or to resolve a difficulty, a doubt, an obstacle, an enigma, a proposition to be resolved. It is a situation that emanates from the reality, from a context, dependent on the optical analysis; it can be a question regarding math, public health, philosophy, etc. For the philosophy, a problem is, in general, any situation involving the possibility of an alternative, which should not be confused with the question, which is a question of the being, a confusion of the his convictions. The doubt, when solved, becomes belief or disbelief.

When it comes to the characterization of a problem it is necessary to consider, in advance, that not every problem can be treated scientifically. This means, to perform a search, it is necessary to determine first, if the contemplated problem falls under the category of science. A problem is of scientific nature, when it involves variables that can be tested, observed, and manipulated. A problem may be determined by practical or intellectual reasons.

The formulation of a research problem requires systematic immersion in both the subject and the literature, in addition to discussions with people who have practical experience in the field (GIL, 2002). The accumulated experience of the researchers, also allows the development of certain practical rules for the formulation of scientific problems. For Bachelard (1996), first, you need to know how to formulate problems. The problem is the genesis of knowledge. In the world of science, problems are not formulated in a spontaneous way. It is precisely this sense of the problem, (which characterizes the true scientific spirit), that all knowledge is the answer to a question. If there is no question, there can be no scientific knowledge. Nothing is apparent. Nothing is free, everything is constructed.

If scientific research is the concrete realization of a planned investigation, developed and written in accordance with the standards lay down by the methodology established by the science (RUIZ, 1982), the method of approach should characterize the scientific aspect of a problem. One of the most important objectives of the scientific research is to understand how the human mind, with or without use of a computer, solves problems and makes decisions.

In the Tayloristic view, every problem, whether personal or social, can be solved with organization and technology. In fact, the identification of a problem is not purely a matter of metrics, but of careful study prior to its transformation practice. De Masi (2000) notes that during the simple day-to-day actions, each individual adopts a unique vision of the world; partly inherited from the past, partly drafted by others, partly built on their own. Since ancient times, many world views are shared, other global models on the basis of which to interpret and guide behavior.

Expanding the human dimension of the problem; Gattaz Sobrinho (2001) states that reality is not there to be discovered by a look that reveals it, in the same way that the physical environment is not there waiting for him to initiate the contact between the organisms, plants and animals that were here beforehand. Reality is the discerned look. Someone else's vision of the reality enables us to build a representation that includes the complexity of reality, full of side effects. Recognized in their own context, the side effects and the generating differences define the problem. From there, a three-dimensional vision is implemented to solve it.

Still on the subject of the interface of human relationships with contemporary problems, Simon (1987), states that the problem solving and decision making processes are influenced by human behavior, since man makes decisions that meet minimum standards of satisfaction and never of optimization. Additionally, he states that the social and natural sciences are closely related, and that natural and social researchers should contribute together to the construction of knowledge, developing skills for solving complex issues, which require both types of competence and wisdom.

Man had always struggled with the attack the cause syndrome, and is also often taken, by the fact fight and the effect cancellation. It is a human tendency to react to the fact and close in the situation, in the race to contain the situation's effects that, apparently cannot be controlled. The identification of the problem should start by addressing the existing issues. A small tour of the origins of the people or events that created the chain of events, that led to the problem would be the surest shortcut to understanding the gears that moved the pieces that currently afflict human beings (LEME, 2005).

The social sciences and the business administrations' knowledge contribute greatly to the development of solutions to complex problems. It is important to consider that the pure science is a socialized science, a science that is part of the scientific community. To belong to the science of his time, it is necessary to deal with science's social relations (BACHELARD, 2004).

A diverse set of tools, methods, techniques and approaches can be used to understand current issues. Gonçalves (2010, p.25) describes the decision making process, by listing some conventional tools for decision support, found in the organizational routine. A reasonable relationship of the technology and knowledge based in the functionality and in the classical sciences is available to the productive resolution. Figures 1 and 2 illustrate the Problem Tree and the Ishikawa Diagram. Both tools are geared toward the activity, and limited in respect to the perception and the vision integral to the process, as well as its side effects.

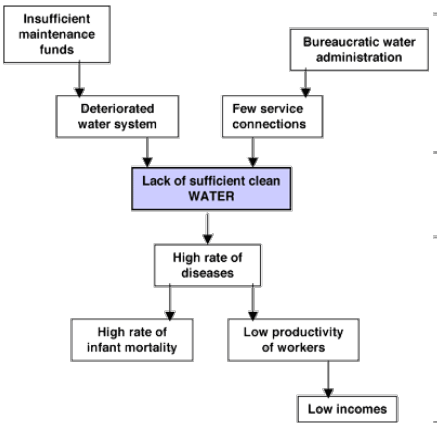

Figure 1 Problem Tree
Source: Bezerra (2010)

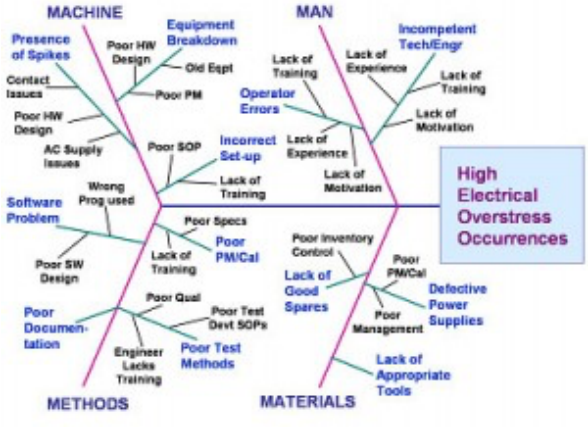

Figure 2 Ishikawa Diagram
Source World Bank Group (2011)

The use of a specific tool for the identification of a problem or of support to decision-making is a manager's choice, and some have low effectiveness, others only to a certain degree. The choice of method or tool reflects on the context to be applied, which may determine the adoption of simple and efficient methods, how to answer the following questions "what, what for, why, how, when, where, and how much?" Accordingly, we present some methodological approaches, tools and theories, such as the Roadmap, the Image Theory, and the Problem-Based Methodology, among other reality representation models, that back up the discussion and provide structure for the framework approach of the productive resolution of complex problems presented below.

The Problem Based Methodology subsidizes the problem identification method, and should be used whenever appropriate, in situations where the issues are related to the search for a solution. The problematization is related to the reality and the human being. The problematization practice has as a starting point the everyday practice (FREIRE, 1987). The research culture promoted by the use of this methodology is characterized by the constant collaboration, so it is inclusive. The basis for the application of the problematization methodology was the Arch Method, proposed by Maguerez in the 70s of the twentieth century, which is based on five pillars: Observation of Reality; Key Points; Theorizing; Solution Hypothesis and Application to Reality (practice).

The problematization is based on the reality of their agents. Paulo Freire (1987) left an important legacy, when he used the problematization approach for the construction of the innovative approach to literacy in Brazil, and later replicated in many other countries. Education as a practice of freedom implies the negation of the abstract man, isolated, loose, disconnected from the world, as well as the denial from the world as a missing reality of men. In the Freirian method, the problem formulation arises due to the common sense or the vulgar knowledge possessed by the student. This is the knowledge that is related to epistemological obstacles. The dynamism of man leads to surmounted obstacles, and realize the necessary breaks to form the scientific spirit in order to allow a new knowledge, understanding, that appears to meet the needs of man.

The Environmental Management of the Intelligence Reality (EMIR), proposed by Gattaz Sobrinho (1999), is a model representation of reality in software technology and of process that self generates the time to incorporate changes produced by the co-evolution of the problem or by its solution, which comes to the same thing, since it is not against such initial conditions from the classical physics, but for the interactive continuity and the co-evolutionary of the problem. Manzano (1999) notes that the EMIR is a contextual machine that works the axiomatic perspective dependent of the context, rather than being fixed and independent. Instead of subordinating the user to the conditions mechanical, and discontinued of the pre-defined solutions by the current software management, the EMIR places the individual in front of his problem, and offers all the known computing resources: thus, allowing the decision making to be based on the safest choice, after simulations of the alternatives. Therefore, re-establishing the sovereign role of the human beings in the management of their world, leaving to the machines their inherent automatic activities, that is the processing of information. The contextual machine addresses the qualitative aspects of reality as opposed to the purely quantitative, or the uniqueness versus the universality.

Road-mapping means creation of a common vision. It is a tool to assist the productive resolution of the problem through the development of strategies. It is a description or the diagram of existing paths and routes - or that may come to exist - in a given domain to achieve a goal. It provides a consensus view and a perspective of the future to support the decision making. The tool provides means to identify, evaluate, and select strategic alternatives that can be used to achieve a desired

goal. It's a learning experience and a communication tool among the participants (KOSTOFF et al., 2001). In relation to the technology, *roadmaps* can be classified into four different groups: sectors, corporates, product-technology, and expertise-research (FARRUKH; PHAAL; PROBERT, 2003).

Van Assen, Van den Berg and Pietersma (2010) describe *road mapping* as a method that facilitates the creation of a shared vision for the future, whose purpose is to inspire, providing analyzes to improve and renew. The *roadmap* model provides a description of how to structure the process of technological evolutions, and organizational, clarifying future goals, as well as the path to achieving these goals. Although specific activities and projects are described in a *roadmap,* the future is unknown and not always predictable. It is, therefore, only a visualization of the future. Although based on technological and market facts, it should not be used as a forecast document. Its frequent updating is essential to incorporate the latest advances in the vision planned for the future.

The method based on language and descriptive analysis of problems (PSL and PSA) was first used in the 1970s. People when confronted with a complex problem tend to reduce it to a level where it can be readily understood, or to use intuition to better understand the problem and propose solutions (ROBBINS, 2000). In view of delimited rationality, the individual makes decisions by constructing simplified models that select the essential elements of the problem without capturing all the complexity.

This model conforms with the following stages: (i) investigation of the need for problem solving or decision making, (ii) simplification of the problem, (iii) definition of the criteria for accommodation in accordance with the minimum standards, (iv) identification of a limited set of alternatives (v) comparison of alternatives, one at a time according to the criteria of accommodation, (vi) verification of the existence of an alternative accommodation (vii) if anyone should select the first acceptable choice and (viii) if inexistent the search should be extended, returning to the stage (v).

The prospect of identifying and solving problems intuitively, prescribes a conscious process that occurs from the depuration of the experience. The image theory (BEACH, MITCHELL, 1990) offers a comprehensive explanation of how most people use intuition to identify and solve problems. Decision making is essentially an automatic and intuitive process, requiring a minimum amount of reasoning. For this theory only two steps are necessary: the compatibility and profitability tests.

The visible problems tend to have a higher probability of being selected than the major ones (SIMON, 1987). Typically, managers are concerned in tackling rationally the most prominent problems, conveying to others that things are under control. The identification of a problem refers immediately to its structure, which has to do with how the issue will be addressed. The rational model is the construction of options for calculating the optimal levels of risk, and choice of alternatives with higher chances of success.

The precise identification of the central problem is the greatest challenge of the productive resolution. The success of a solution is proportional to the precise identification of the core problem. The genesis of the resolution is in the productive identification of the problem, not in any out of context solution. However, some management mistakes can occur when trying to solve a given problem from a solution *(solution-based methodology)* already found. The use of *benchmarking* – marketing strategy – requires attention from the manager due to the contextual risks that the solution itself carries. The adoption of any solution should be of a relative manner, careful, respectful of the context to be used.

3.1 Concepts associated with the complex problem-solving approach

In order to minimize the conceptual biases, it is important to explain the meaning of the common terms in this investigative process. A review of classic works and the dialogue with contemporary authors favor the alignment of the context terms, process, complex, transdisciplinary and action-research within the identification scope and characterization of complex problems.

The search and the convergence of these concepts are justified because, they show how essential it is to identify the problem, why the need for the identification, and adoption of the productive resolution, as well as the scientific importance of the solution.

3.1.1 A Contextualization of the problem

The text linguistics and the evolving meaning of the term "context" facilitate the understanding of the significance of the problem/solution, as well as the knowledge. Galembeck (2011) states that man has the ability to receive new information; thus, to understand what goes around him, because the acquired information is associated with the network of conceptual representations at his disposal.

In this sense, nothing is completely new to man, and what he does not understand consists of information that cannot be associated with his network of relationships. This network, even if partially, is shared by the members of a community, and in this sharing, it creates a common cultural context on group membership. Thus, the transmission of information should be associated with the creation (or recreation) of this common context, through various discursive procedures.

Considering that the physical, social and psychological worlds reflect the everyday problems, and that the individual reality is a representative cut of the cultural, scientific and spiritual heritage of a nation, a group, a community, one can understand that the quantities of contexts are endless and they can be used to give meaning to the knowledge.

Etymologically, contextualize means to root a reference in a reality, from where it was extracted, and will lose a substantial part of its meaning when placed away from it, so it is a fundamental strategy for the construction of meanings. The contextualization guides the understanding of the knowledge for everyday use, taking advantage of the relationships between content and context to give meaning to the new reality. The meanings are not neutral, since they carry valuesthat explain the everyday, and facilitate the understanding of issues related to the social and worldwide environments.

3.1.2 The problem in the process, the process of the problem

Since the problem is procedural, Gattaz Sobrinho (2001, p. 106) explains that "the principles of the world view in process are humanity's cultural heritage", and all that is human is necessarily co-evolutive. In this world view, the principles are invariant and help to set priorities and to recognize the process itself.

In process, according to Gattaz Sobrinho (2001, p. 181), one knows where to go, but the course is only disclosed during the construction of the path. Relating process to the system, Maturana and Varella (2001) define a system as a set of relationships between its components, regardless of these components. Organization is the ensemble of relationships that defines a system as a unit. The main

feature of a system is its ability to self-organization, as well as the community and the land resources.

The process under the management focus is not limited to the vision of the process industrial, legal or creative. From this perspective, the process is the set of decisions that transform inputs into values; results achieved by decisions made by the people. Still on this approach, the process focuses on the quality of the result to be generated from the interaction of the chain of values.

The Brazilian Ministry of Planning, Budget and Management, through the Public Management Program, offers a content management process as a tool for public management, available at <http://www.gespublica.gov.br/ferramentas/pasta.2010-04-26.0851676103>.

Any process can be modeled, in other words, modeling is the map that shows the intelligence of the process, and help to understand the adjustments that alter the changes to the process. Additionally, it explains that modeling is the name of the process used to make the design that expresses the complexity of a process and allows for simulations, generating alternatives and optimizations. It is the very representation of reality, all the way, the process method, is explicit in the modeling.

Whereas, the map of the process absorbs the changing context, the changes imposed by the context can be included at any time, representing a breakthrough in the process of identification and the productive resolution of complex problems.

3.1.3 Complexity of the problematic

The complexity consists in understanding the ensemble of several elements that are interrelated as such, that together, they are showing an organized structure and behavior. However, the complex thinking is the generator of big misconceptions, even when common sense postulates that the complex is the opposite of simple.

Complexity corresponds to the multiplicity, standing for: to think a new paradigm, i.e., a new set of ideas that are conceptually accepted. The complexity paradigm stresses the idea of unity and duality of man, a physical and metaphysical being, natural and cultural. The paradigm of complexity sees as mobile what the classical logic sees as static. It aspires to the multidimensional knowledge. The simplifying thinking is incapable of conceiving the conjunction of the one and of the multiple.

In view by the Santa Fe Institute: complex systems arise naturally in the economy in a situation of non-equilibrium (FONTANA, 2010, ARTHUR, 2010). The complexity sets a new world view, which accepts and seeks to understand the concrete changes of the real and it has no intention to deny the contradiction, the multiplicity, the randomness and the uncertainty, but to live with them instead. It deals with the order, the disorder, the intention and the organization. It is therefore a plural thought.

With regards to the complexity, Simon (1976) explains that one of the most interesting aspects that differentiate the human social organizations from other complex adaptive systems is the possibility that human beings have to choose how they should operate in practice. Recognizing the connections through which the most relevant outflows occur, and identifying the points with the most and the least multiplier effects; it is possible to direct the resources – whether information, knowledge, materials, or trust, to name a few – more appropriately.

The complexity indicates that it is woven together, that everything connects to everything and, reciprocally, in a relational and interdependent network. Nothing is isolated in the cosmos, but always in relation with something. At the same time that the individual is autonomous, he is dependent on a roundness that distinguishes and differentiates simultaneously (MORIN, 1999).

An epistemology of complexity not only incorporates aspects and categories of science, philosophy and the arts, but also various types of thought, whether mythical, magical, empirical, rational, logical, in a relational network that brings out the subject in the constant dialogue with the object of knowledge. It considers the communication among the various areas of knowledge and understands order, disorder and organization as important and necessary steps in a process that culminates in the auto-eco-organization of all living systems (MORIN, 1991).

3.1.4 Trans disciplinarity - the interfaces and the various faces of knowledge of a problem

For Morin (1999), trans disciplinarity is the practice of what unites rather than separates the multiple and the diverse in the process of constructing knowledge, and also presupposes the use of different languages. Weil, D'Ambrosio and Crema (1993) refers to trans disciplinarity as a new way of being, knowledge and approach; a practice of the knowledge dialogue, but without exemption from the diversity and the preservation of life on the planet.

For Tanik et al., (2003), the transdisciplinary research is an emerging field in the knowledge society, that relates to science and politics in addressing issues such as global and local environmental concerns, migration, new technologies, public health and cultural change. The integration, participation, values and uncertainties, learning, management and education are some of the transversal challenges to the trans disciplinarity. The transdisciplinary model has diffused interfaces without barriers, where communication and interaction are easily obtained.

The indispensable need for links between different disciplines has led to the multi disciplinarity and inter disciplinarity emergence in the mid-twentieth century. To Nicolescu (1999), trans disciplinarity indicates what is at once between the disciplines, across the different disciplines and beyond all discipline. Its goal is to understand the present world to which one of the imperatives is the unity of knowledge.

Additionally, considering that trans disciplinarity is an absurdity to the classical thought, because it has no object. In turn, for the trans disciplinarity the classical thought is not absurd, but its scope of application is considered restricted and that it does not consider the context. Although, the trans disciplinarity is neither a new discipline nor a new hyper-discipline, it is nevertheless, nourished by the disciplinary research which, in turn, is illuminated in a new, fruitful manner by the transdisciplinary knowledge – a contextualized fusion of disciplines.

3.1.5 Action Research - real-time action

Action researches is an empirically based social research that is designed and carried out in close association with an action or with the resolution of a collective problem, in which researchers and participants representative of the situation or problem are involved in a cooperative or participatory way (THIOLLENT, 1997). Action research is a method of conducting applied research, focused on developing diagnostics, identifying problems and finding solutions.

Participation in research is a process generated according to the need to build anticipation and language. According to O'Brien (2001) and Westbrook (1994), this participating way is distinguished from the general professional practices of consulting, and troubleshooting day-to-day problems since the researcher has systematically studied a problem, and has ensured the intervention knowledge by theoretical considerations. Much of the time the researcher focuses on improving the methodological tools to meet the requirements of the situation, and in the collection, analysis and data presentation.

Lindgren et al., (2004) characterize the action research as an intervention method that allows researchers to test hypotheses, and to access the changes in the real scenario. In this type of research the researcher assumes responsibility, not only to watch the players involved through the generation of knowledge, but also the application of this knowledge.

Action research applies to cases where it is necessary to collect subtler and significant data. Thus, by virtue of the broad insertion of the researcher in the context of the research and his involvement along with members of the researched organization around a common interest; the data becomes more readily available in an action research (EDEN; HUXHAM, 2001).

According with the composition proposed by Stringer (1996), the action research comprises a routine of three main actions: to observe, gather information and build a scenario; think, explore, analyze and interpret the facts, and act, implementing and evaluating the actions. Within this same idea, the action research process can be divided in four main steps, which are described below: exploratory, main, action and evaluation phases (THIOLLENT, 1997).

It is particularly noticeable that in seeking a resolution of any problem, any solution is accompanied by a new problem. It is what is called self-recurrence. In this sense, Gattaz Sobrinho (2001) asserts that when faced with the same situation, each person, institution or organization is different from it, and is facing a problem that is always a new problem, for having incorporated therein the previous solution.

Increasingly, individual researchers, students, professionals, entrepreneurs, artists, citizens and others are looking for an efficient way to undertake and better see the reality, allocating their skills and putting them into practice; thus, making the change required by the context. Special attention should be given to the obsolescence of knowledge; since the speed and pressure for change may prevent the reutilization of a successful solution in another context.

4 Approach to Complex Problem Solving Oriented to the Process

The identification of the contemporary world's complex problems has the characteristics of scientific knowledge, as it searches for the relations between the components of the phenomenon to enunciate general laws and the constants that govern these relations (RUIZ, 1982). In order to prove the hypotheses, validation of the theoretical subsidy and the scope of the proposed objectives; the problem has received a contribution of methods and techniques. This approach to Complex Problem Solving was modeled on the Method of Process Oriented Research (MPOP) – proposed by Argollo Ferrão (2004), and in the Process Principles and the Technology Platform PArchitect – stated and developed by Gattaz Sobrinho (2001), and the video containing 8 hours of discussions between Argollo Ferrão and Gattaz Sobrinho recorded in 2008, in the context of the

discipline "Method of Oriented Search Process" created by Argollo Ferrão in 2003 and taught until 2010 at the State University of Campinas (UNICAMP).

The POP Method has the trans-disciplinary approach and adopts a systematic approach and the process view to enhancing the heritage and cultural landscape: social and cultural developments, civil, collective and individual. The method promotes discussion about common sense, expectation and scientific attitude, the classical science of the object and the science of the difference. The principles seek clarification of the design process by means of communication, language and representation of processes that value creativity and management of knowledge: art and science, dreams and reality. The POP method uses the Principles Process enunciated by Gattaz Sobrinho as a reference; however, adding unique aspects resulting from the its transdisciplinary approach, and the systemic approach according to Argollo Ferrão (2007).

The POP Method has co-evolved with the research conducted at the Laboratory for Developments in the Areas of Water Resources, Energy and Environment at the State University of Campinas - O Labore Unicamp – since 2003, basing them, sometimes driving them, or being driven by them, especially those that take place beginning with the Rural Architecture's problems (ARGOLLO FERRÃO, 2005 and 2006), watershed planning or regional planning, territorial resources management problems and the corresponding heritage – outlining the cultural landscape, territorial ordination problems in the face of a sustainable regional development process, and various other problems in the same line.

The environment PArchitect is a software tool that assists in the development, integration and process management. It is an innovative solution not only for allowing the identification of the context in which the enterprise develops, but also by allowing the simulation, emulation and enactment of business processes in their real context instead of the hypothetical one.

The twenty-one process principles enunciated by Gattaz Sobrinho (2001) were taken as elementary for the Approach Complex Problem Solving Oriented to the Process Principles. The principles help the representation of reality, which helps to establish priorities and recognize the process itself. The recognition of new principles is free and only reality can refute them.

The PArchitect technology deals with the business management problematic at zero time, and among the numerous advantages are these highlights: the dispensing of the systems generated maintenance and the automatic generation of systems, with the consequent absence of error correction. It should be noted that the PArchitect is not an offer to perform, but a real computing environment, existing, available and approved, that captures the reality of any kind of proceedings and record them on the computer.

As a result, these processes can be an object of a management (continuous optimization) with all the informatics virtues: simulations speed allows for the exhaustion of the alternative optimization, to register models, documenting the metrics, etc. The process modeling tool shows the details of all the components and enables the generation of reports for the completeness of decisions, of references, of infrastructure and of values, etc., comprising the process. Additionally, the technology generates reports for each planning component.

In the problem modeling process now adopted, the individual responsible for seeing the phenomenon is known as the problem's student. He is motivated by the concern, by the change –

the inherent in the entrepreneur. The minimum requirements are: interpersonal skills, a proactive attitude, and sufficient basic knowledge for the oral and written communication. The fulfillment of these requirements allows the inclusion of a large number of subjects, or citizens of the world, as students of a phenomenon with skills to identify and characterize a complex problem.

The principles of the world view in the process, the existing theories of problem identification and action research will serve as reference for the identification and characterization of the problem. The universe is the infrastructure designed for the problem, which expands the model replicating possibilities. Decisions are activities or procedural efforts aimed at obtaining a difference, resulting in the Approach proposed here.

As shown in Figures 3, 4, 5, 6, 7, 8, 9 and 10, the Approach to Complex Problem Solving Oriented toward the Principles of Process is the resulting panel from the PArchitect technological application. It consists of two instances: (i) Identification and Characterization of Complex Problem Oriented to the Problem and the Principles Process, (ii) Productive Resolution of the Complex Problem Oriented toward the Principles of Process.

The first instance (Figures 3, 4, 5, 6, 7, and 8) shows the identification and characterization of the complex problem from the collation with the principles process. Initially, according to Figure 3, the phenomenon should be noticed, searched for factuality, and truthfulness, its actuality and scientific character, avoiding confusion with ephemeral thoughts, without substance. The absence of these features does not justify the continuation of the process. Later, the student must seek discernment, the problem's characterization, from the collation with the principles of world view in the process.

Figures 3 and 4 show that the unity, recognition, proto-interaction and the zero time principles serve as the initial prospectors of the accuracy, the usefulness, and the actuality of the problem studied. The Approach to Complex Problem Solving Oriented toward the Principles of Process makes the assumption that the unit is the human being and its context and not just a cut of any reality, that is, a territory, a watershed, an institutional arrangement or organization.

Figure 3 clarifies the collation of the problem with the principle of Unity, according to which the unit is the human being, acting in an infinite possibility of contextual modes of being, of building new access bridges to reality. It is the unit that recognizes its differences among these existing modes. The unit characterizes and articulates a mode of existence, in which everything is revocable and that nothing is definite. At first the unity precludes analytical insight, which separates the subject from the object.

It compares the problem with the Recognition principles in order to see inside someone else as part of it. To recognize you in someone else is to feel what he feels. And it is not limited to human being, it can be plant, stone, anything (Figure 4). Relating to the above principles, it is the problems' collation with the Proto-interaction principle to exchange information with the reality, and to understand the problem's incompleteness; thus, reducing the risk, and clarifying the side effects that could bring new risks or new contributions. The Proto-interaction allows for the understanding of the uncertainty as an imaginative richness that stimulates the production of prototypes, of emulations, that are exercised interactively to better observe the problem. As the context changes with the co-evolution, the proto-interaction adapts to change.

It also compares the problem with the Time Zero principle (Figure 4), which is the time it takes to fully recognize the problem. All the intelligence gathered is reusable, and it is important to discard the fixed forms of representation in order to reduce to zero, the time between the solution and the application of the result. If the problem exhibits a solution, then the collation with the other principles becomes unnecessary.

Then, in the process' synchrony, the problem is compared under the following principles: Co-evolution; Inclusion; Change; Integration with zero energy; Parallelism; Duality; Self-defense; Reconstruction; Exponentiation; Context; Weakly Structured, Veracity, Synchronicity, Trans disciplinarity; Auto-recurrence, Sharing, and Decidability, shown in Figures 5, 6, 7 and 8.

The second instance (Figures 9 and 10) explains the modeling and formulation of possible solutions, simulation, solutions' optimization, emulation, and finally the staging process. After complying with the risk and waste mitigating measures; the implementation of the planning, the monitoring, and the compatibility analysis of the solution and the self-recurrence caused by the problem's co-evolution occurs.

5 Results and Discussion

The problem or context is unique and expresses the difference, where reality is seen as a state of change. These principles should be used in the criteria generating process for problem solving or decision-making; they are what infuse man with the certainty that he himself is the beneficiary. The work resulted in an Approach that reflects a set of principles, and structural elements that can assist in the identification and characterization of complex problem and its solution.

The Approach to Solving Complex Problems Oriented toward the Principles of Process describes the collation between the problem and life's principles. This collation seeks validation for the result, the added value, the difference, as a universally accepted approach to problem identification. The Approach is different in the modeling process, the intelligence map, which highlights the *inputs* or stimuli that motivate the emergence of a given problem. The modeling also shows the references; the human and technological resources used in the synchronization of decisions or transitions. In addition, it shows the *outputs* of each decision, here called differences or added value.

The model shows the path of a student interested in solving a complex problem. Specific attributes may be enhanced during the identifying process of a complex problem because the decision or the transition is a context dependent function. For example, in a given context, one problem has its own meaning and can be subjected to a greater or lesser number of principles of the life in the process, generating proportionate number of transitions or decisions. The same problem in another context can assume different meaning. Therefore, the problem and the approach may vary according to the contextual change.

The identification of the problem according to the principles of the unit, the recognition, the permanence and the zero time represents 80% of the process' *timing*. These principles are fundamental to the identification process. The remaining 20% are due to the problem's collation with the remaining principles. A summary of the problem's characteristics results from the collation. The synthesis of the features results in a set of differences that define the problem, which will serve as input for the modeling decision and formulation of solutions. The "possible solutions" result from the value or difference from this decision.

The difference or value added to the "Possible Solutions" becomes the input of the decision to simulate the problem, resulting in the value called: "Characteristics of waste, of residues and of the problem's synchrony." Next are the model's optimization, emulation and, finally, the staging of the problem. After the staging, the student may realize that the problem has turned into a new problematic, rather than revealing the solution. This phenomenon is due to the change and the co-evolution. Nothing is static, especially when related to the process of identifying complex problems. Therefore, the discovery of a new problem is the effect of solving an old one.

The process of identifying and solving complex problems can be somewhat facilitated in the accurate measurement of the proximity, or the remoteness of the student with the reality. Hence it follows that, he who does not experience or share a particular context tends to show higher dispersion and difficulty in observing the nuances of the process.

6 Conclusion and contributions

In situations of problem identification and decision-making individuals tend to operate a definable rationality or intuition in their decision making. The correct and accurate problem identification avoids misdiagnoses and misleading solutions. The side effects of the inaccuracy or deception focus on the risks, the waste and the frustrations of those involved in the process. A real understanding of a problem requires the identification, the characterization and the collation of its features with universally accepted principles.

The problem identification generates knowledge for the improvement of processes, able to mitigate conflicts, uncertainties, and difficulties, of social (in) justice. The correct identification of a complex problem is feasible, trying to add a value, to pursue a difference, because it promotes citizenship, the increase of man's relationship with his fellowman, with nature, with the universe.

The development of an identification approach distinct from the conventional - centered on the solution - means moving toward the respect for the human being and the observation of the context. This approach tends to define a new paradigm for solving complex problems. The proposed approach for identification and characterization of complex problem refers to the phenomenology of the research, the perceptions of reality and the shortcomings of classical and contemporary theoretical approaches that address this question. These elements encourage, or rather act as an input to the process of problem identification.

The communication and information technologies (ICT) provide limited contribution toward their own developments, the specifics of any problem. The attributes from most of the existing technological resources should improve visualization of the problems' process through friendly interfaces. Moreover, among accessible ICT, PArchitect is the only one featuring modeling, simulation and emulation. Accordingly, the modeling process was chosen, more specifically the technology platform, to support the chosen strategy, because it respects the complexity, the multidimensionality and the trans disciplinarity, among other inherent characteristics of the complex social problem. The technological environment allowed the modeling of the problem, and the creation of the approach to complex programs identification and characterization.

In the modeling of the complex problem identification process, the student defines the way to go, according to his own reality. Thus, the student may use different combinations of transitions or decisions, according to his knowledge, his views of reality and of the problem. The results of the

research lead to the challenge of validating the approach's expectations, borrowing from random contexts. They also indicate the need to develop a tool to respond interactively to questions found in the core of the approach.

The Approach to Solving Complex Problem Oriented to the Principles of Process focuses on the particular context of the problem, followed by the various ways to attempt the characterization to reduce the difference between satisfied and unsatisfied. With each learned result, new knowledge was generated and accumulated in the process of resolving the problem. The proposed Approach to solving complex problems was based on the systematic study of the problem's identification and characterization process and the theoretical considerations, challenging the perceived trend of simplification in the midst of the Delimited Rationality and the Image Theory Models applied to the decision making process.

The rational and quantitative models have limited use for the identification and characterization of the problem since, it defies the possibility of contextualization and humanization of the issue. They can be useful and applicable in the modeling process, specifically for the simulation of the problem. The simulation used in the Approach, as well as the delimited rationality, seeks to maximize the utilities, incorporating the economic rationality.

The proposed Approach partially refutes the classical methods for the productive resolution of problems, focused on the solution, since they disregard context and restrict the creativity and the dynamics required to solve complex and contemporary problems. The methodologies such as Problem-Based Methodology (PBM) and Solution-Based Methodology (SBM) mentioned in the Theoretical Referential, were also observed but not considered in full, due to the inability of contextualization.

The *Road-mapping* focuses its analysis on the consequences, in the determination of objectives and the path to achieve them. The most successful *road maps* are created by key people from businesses and universities and, when supported by advocates they tend to be more easily accepted. By comparison, the Approach to Complex Problem Solving Oriented toward the Principles of Process goes beyond the technological and market emphasis, and it is independent from experts and the involvement of advocates.

Moreover, the Approach reverberates and converges with problematic method, aligned with the proposal by Freire (1987), and the EMIR (1999), where the change can be seen only when the language can also be seen, which shows the behavior of the context. Everything is subordinated to the representation of context, to the language. With the language, come a large number of alternatives. If the context changes, the language also changes.

The researchers' efforts were concentrated on improving the methodological tools to meet the requirements of contextualizing the complex problem. The principles that guided the Approach also align with the complex and interdisciplinary nature of contemporary problems. The complex problem is a reality with manifestation of the differences, the behaviors, and the events witnessed by the student. To better understand the problem, reality needs to be seen through someone else's representation. The reality is the set of views of how something appears to somebody. Someone else's vision of the reality enables a representation that includes the complexity of reality, full of side effects.

One approach when subjected to numerous visions determines an order in the discussion and ultimately generates a method. The contribution of the "Approach to Complex Problem Solving Oriented to the Principles of Process" is the possibility of creating a family of methods, from different perspectives, the view of many students interested in complex problems. The Approach then is subjected to different views, a large number of people in different contexts, can be exponential, generating multiple and creative ways of representing the reality, a source of wealth for the problem solving.

It is in this context that the Approach to Solving Complex Problem Oriented to the Principles of Process proves to be more beneficial when compared to the conventional methods: the possibility of representing the problem with the widest possible range of views, without worrying about excluding the conflicting and inconsistent ones. Therefore, the diversity makes interpretation for a more robust representation of the reality. The conflict and inconsistency of the problem's vision facilitate its resolution, because there are a greater number of alternative solutions, enhancing the process's vision of the problem.

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ANNEXES

1 Legend of the PArchitect iconography

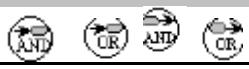
ICON	MEANING
	Decision
	Reference
	Difference or added value
	Association of flow value
	Association of reference flow
	Association of infrastructure flow
	Human resources
	Environmental resources
	Technology Resources
	Connectors and/or

Figure 3 Modeling Process of the Approach to Complex Problems Solving Oriented toward the Principles of Process – Part 1

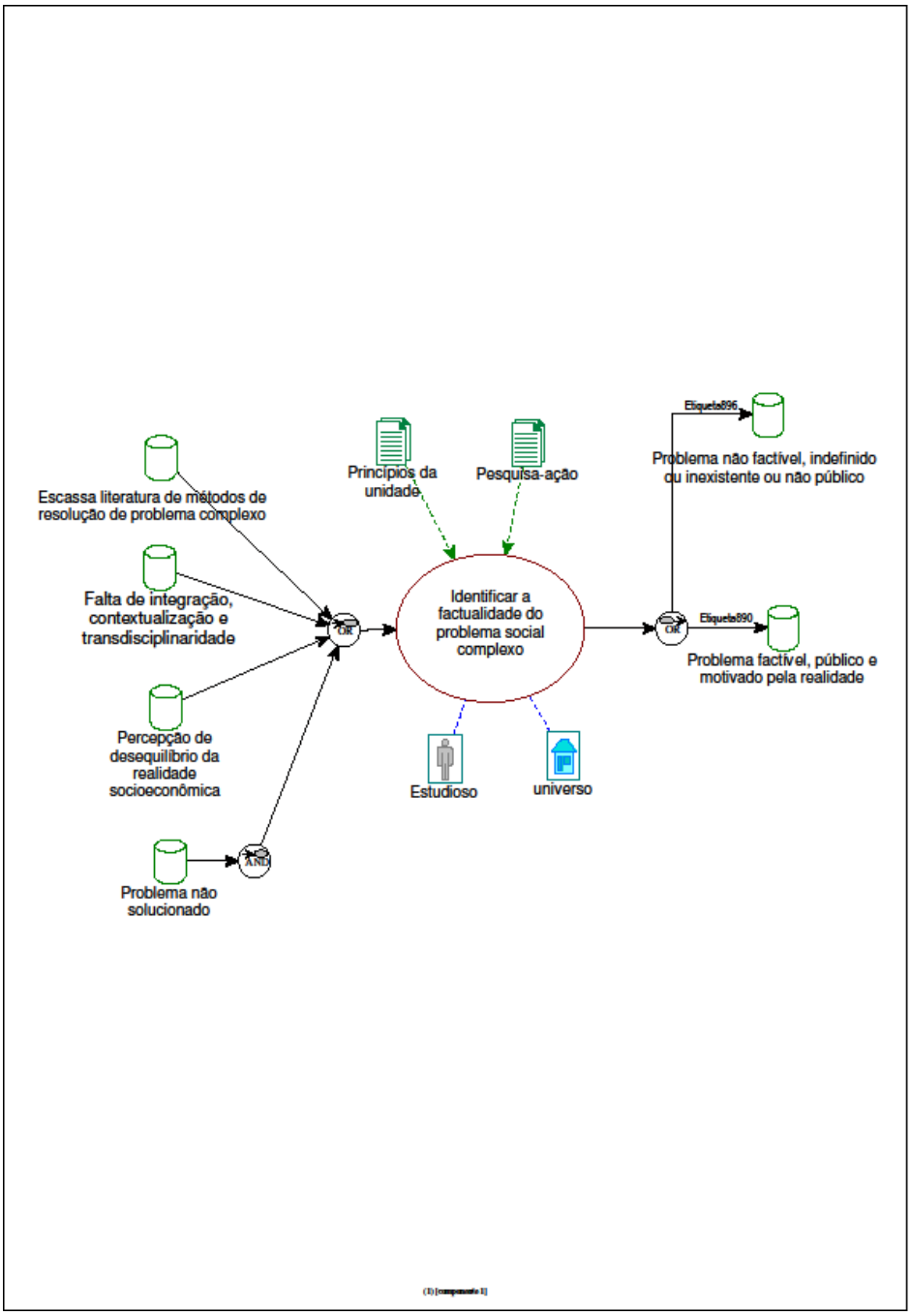


Figure 4 Modeling Process of the Approach to Complex Problems Solving Oriented toward the Principles of Process – Part 2

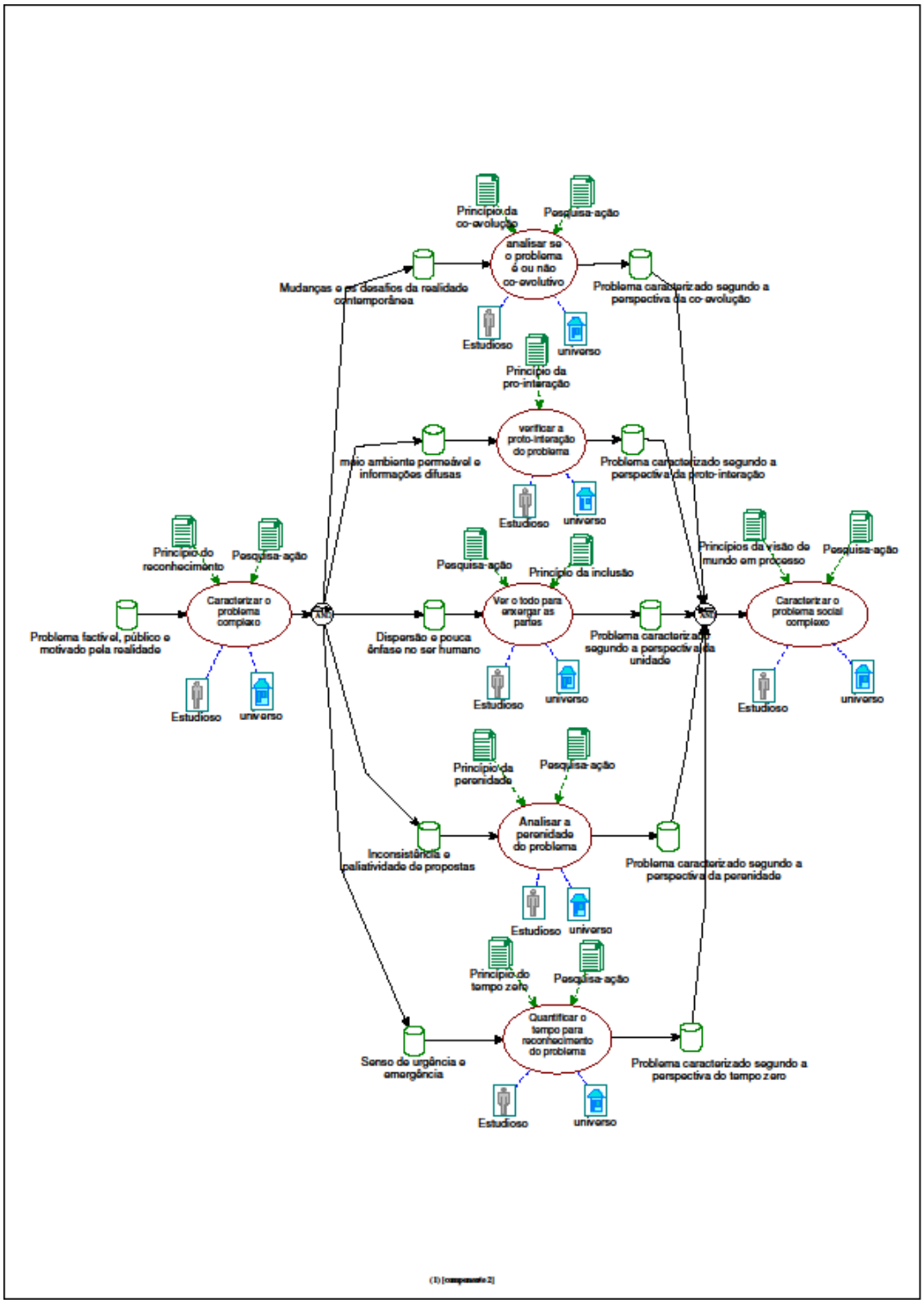


Figure 5 Modeling Process of the Approach to Complex Problems Solving Oriented toward the Principles of Process – Part 3

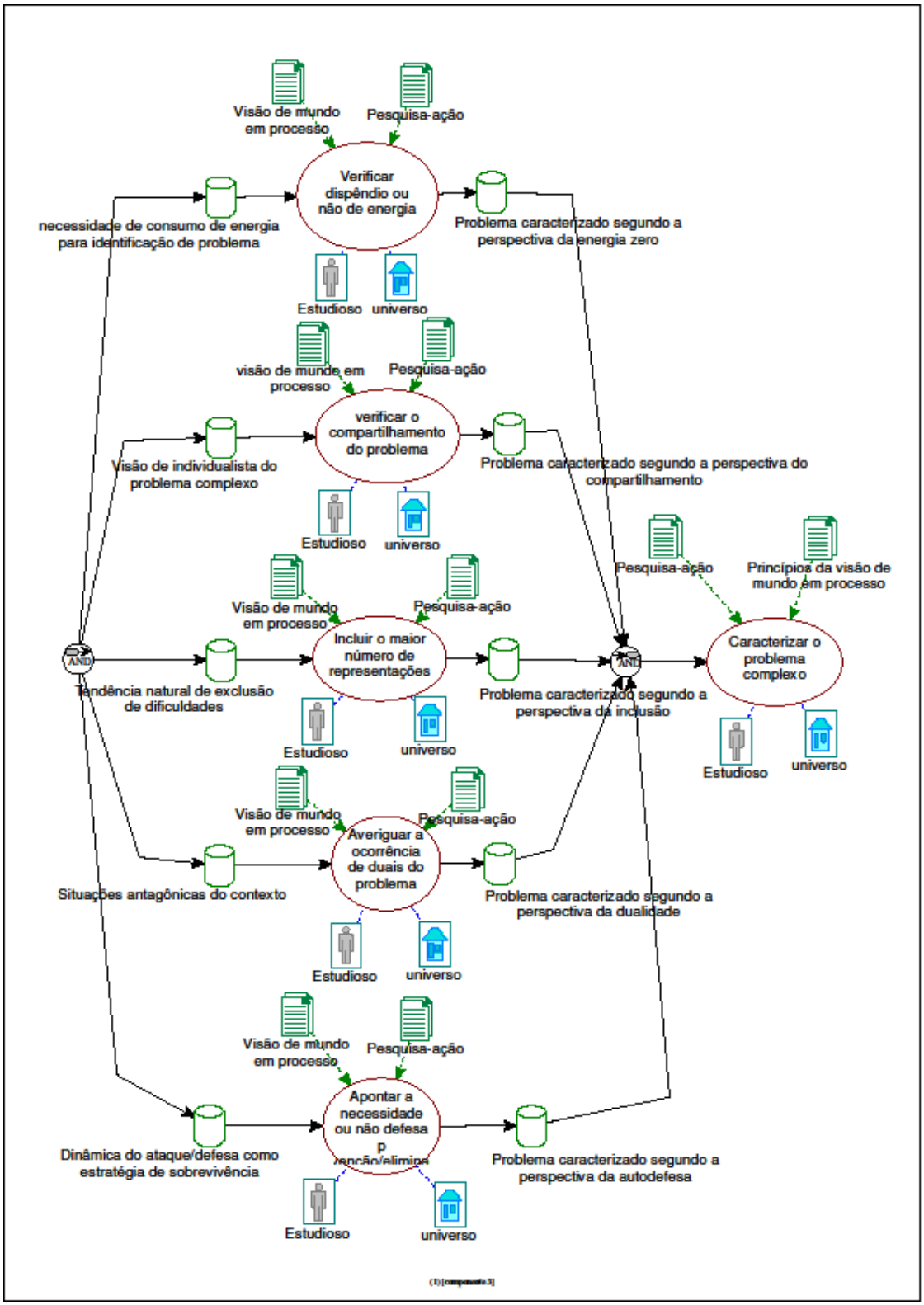


Figure 6 Modeling Process of the Approach to Complex Problems Solving Oriented toward the Principles of Process – Part 4

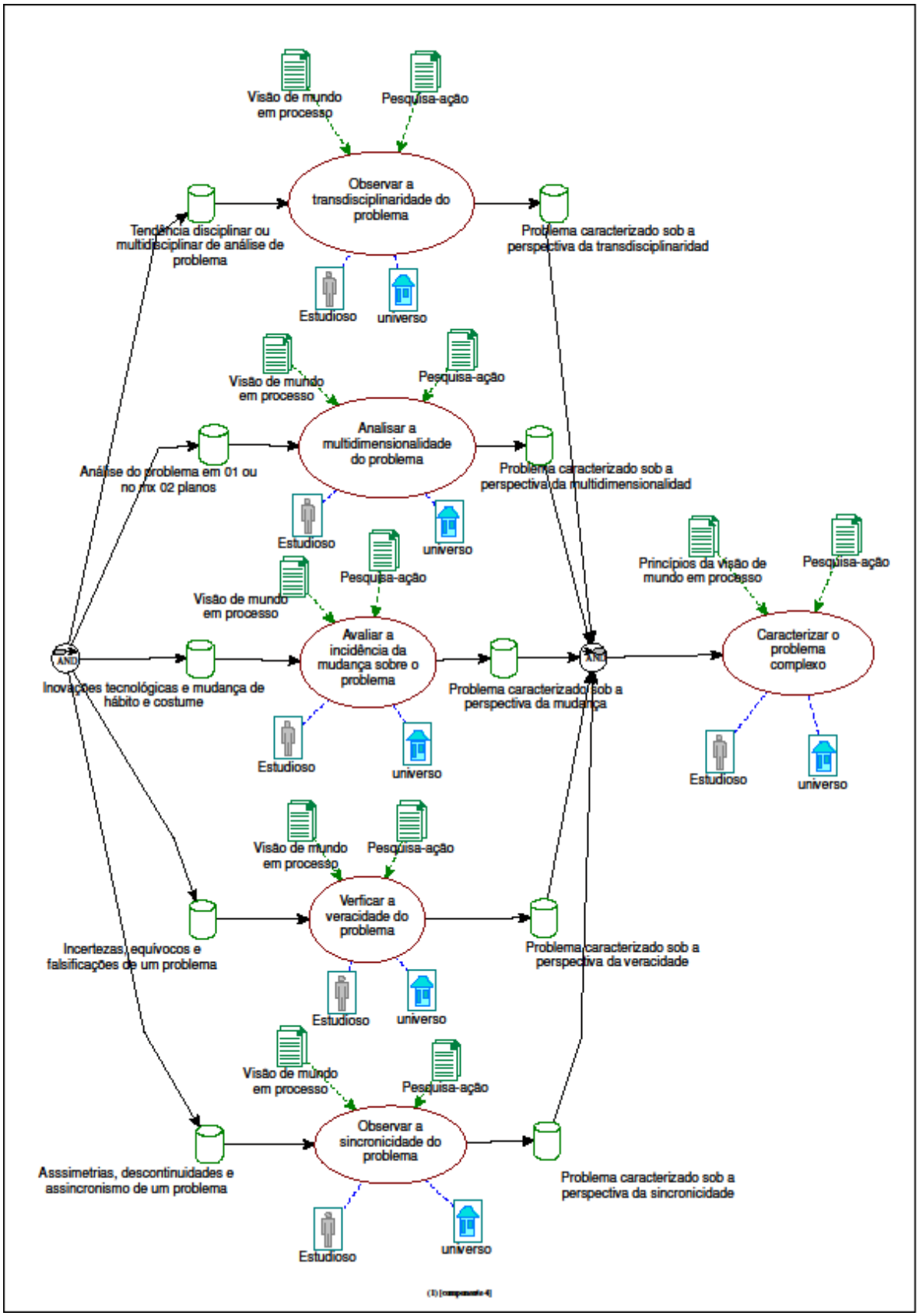


Figure 7 Modeling Process of the Approach to Complex Problems Solving Oriented toward the Principles of Process – Part 5

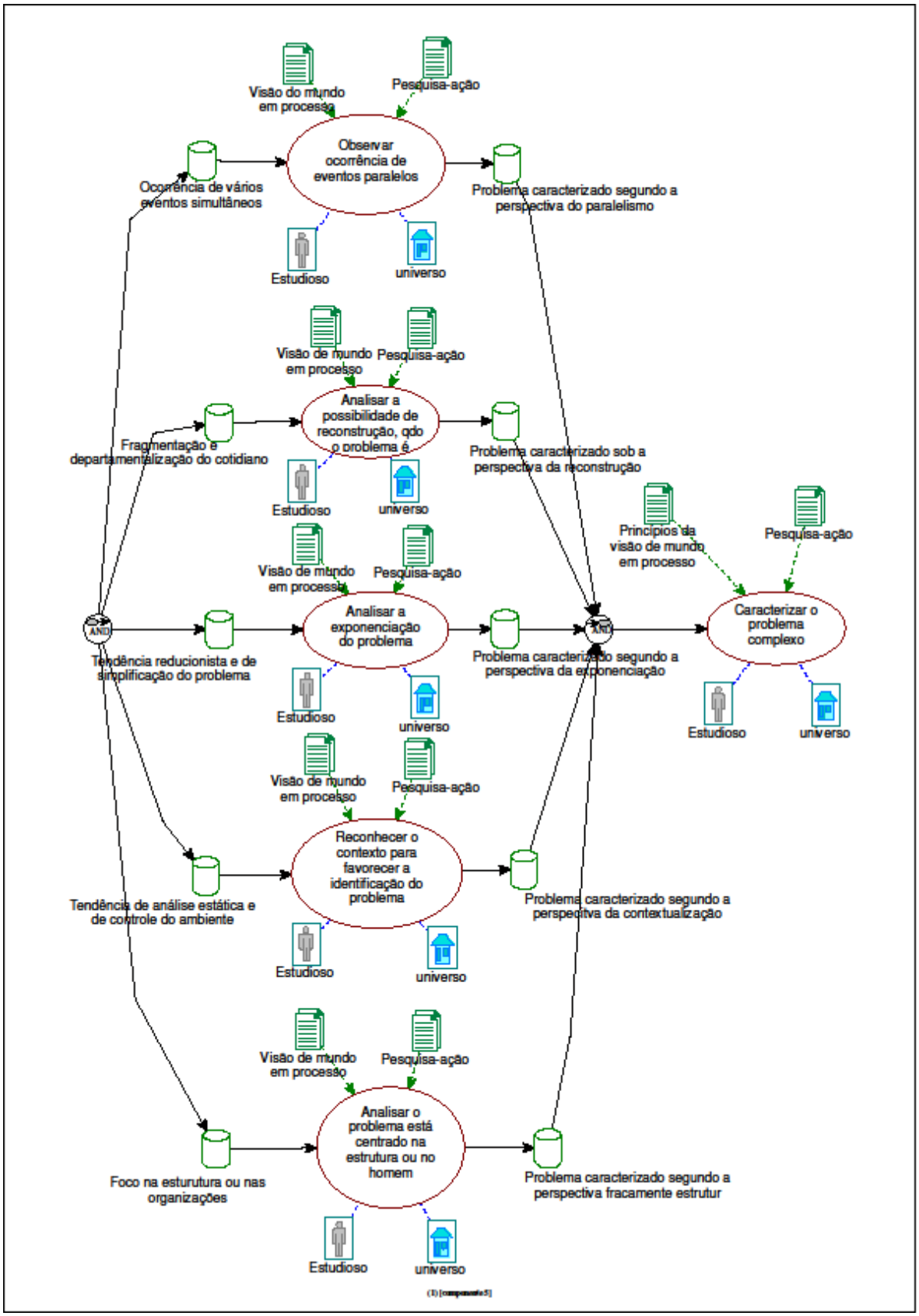


Figure 8 Modeling Process of the Approach to Complex Problems Solving Oriented toward the Principles of Process – Part 6

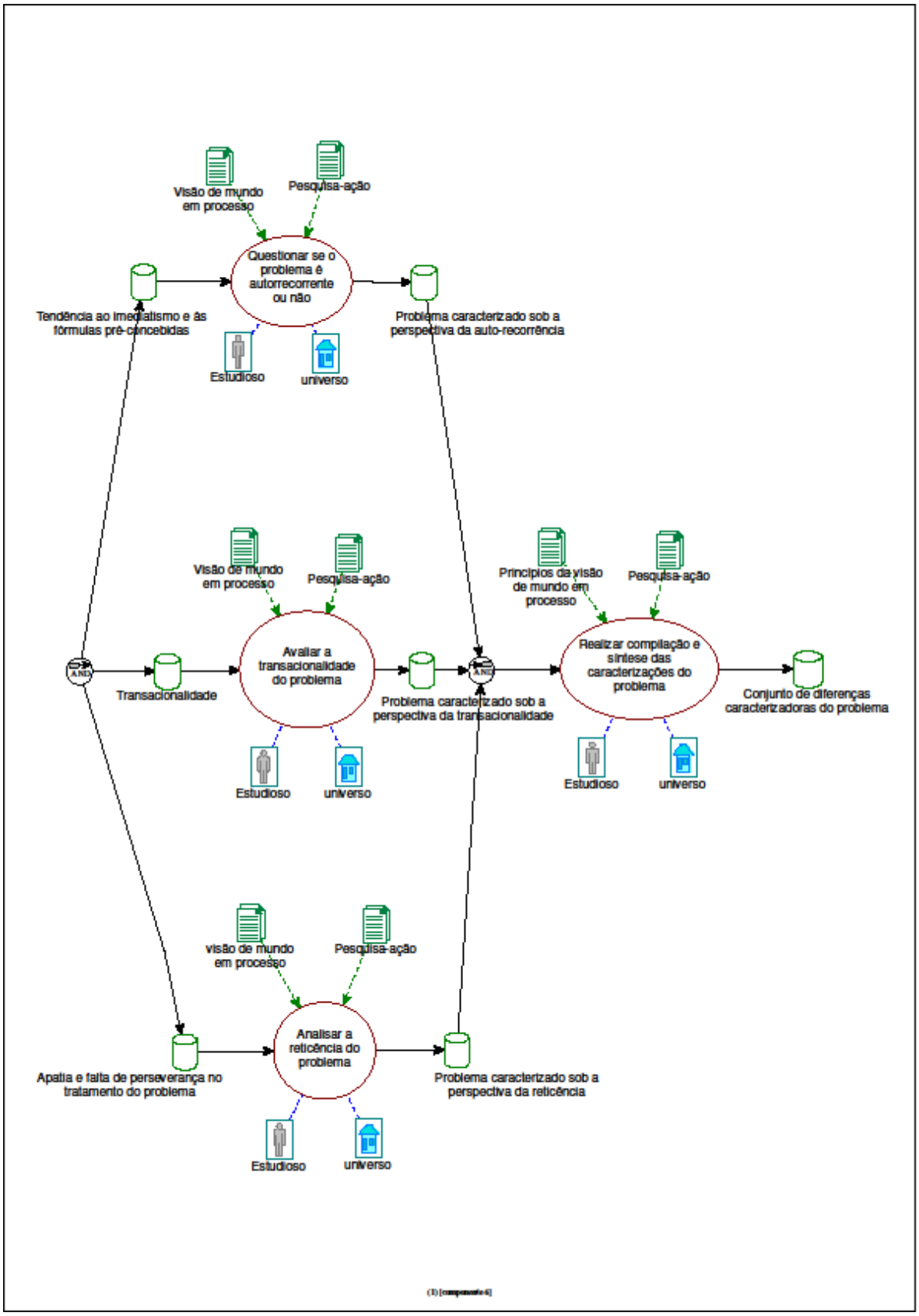


Figure 9 Modeling Process of the Approach to Complex Problems Solving Oriented toward the Principles of Process – Part 7

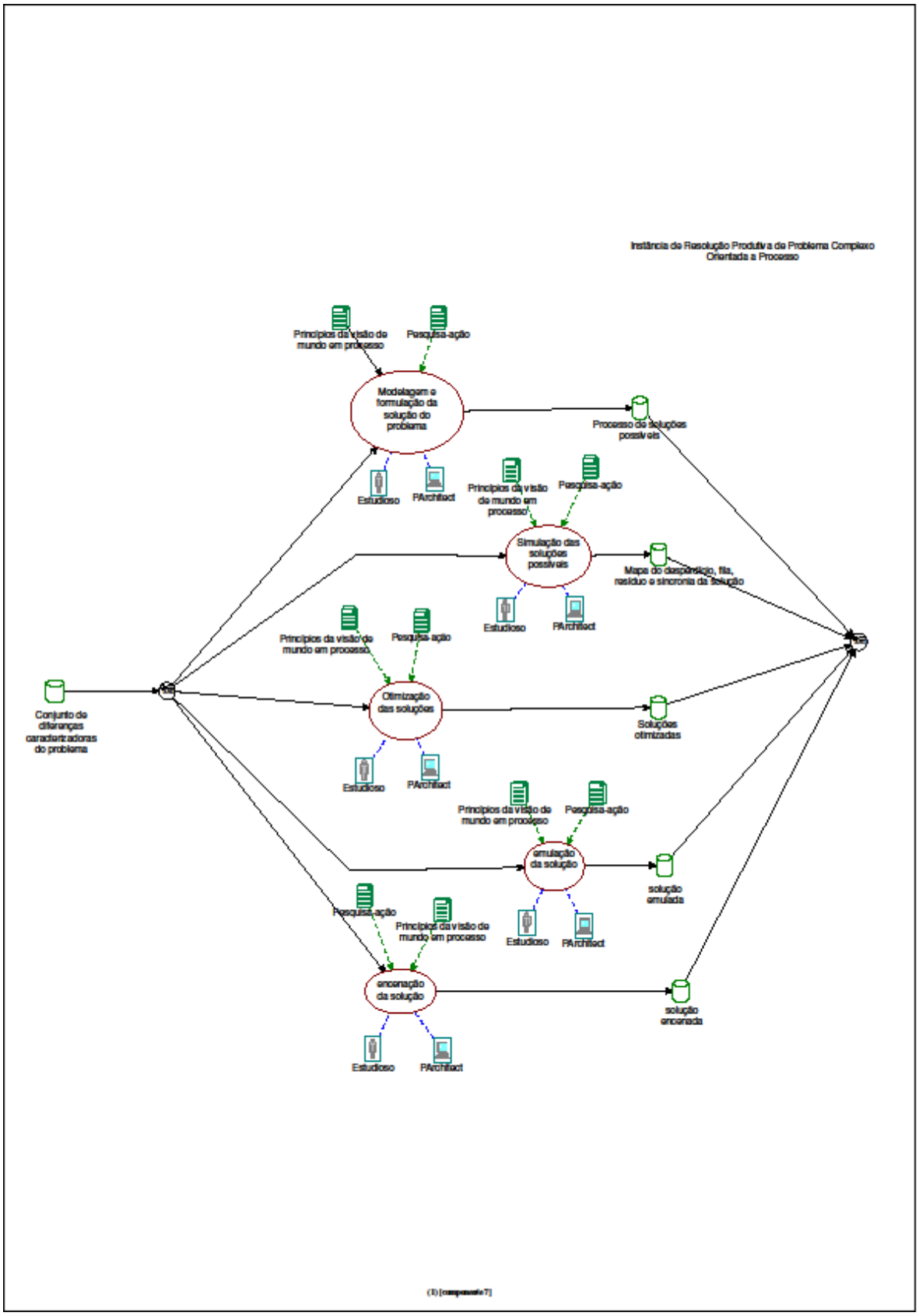


Figure 10 Modeling Process of the Approach to Complex Problems Solving Oriented toward the Principles of Process – Part 8