CHAPTER 11

SYSTEMIC DESIGN FOR EXTENDED SUSTAINABILITY

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"The land can offer enough to satisfy the needs of all men,
but not the greed of all men."
Mahatma Gandhi

In the field of design, environmental issues have always provoked concern and actions. The text presents approaches of several researchers, theoreticians and professionals in the field of design, as well as in the area of economy, ecology, geography, sociology, philosophy and physics, to confront such a thorny and complex[1] theme as sustainability[2]. At this point, a project methodology that deals with this issue in a broader way is highlighted, through the adoption of a model based on a holistic[3] and nonlinear[4] vision, called systemic design.

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1 "Complexity is a fabric (*complexus*: what is woven together) of inseparably associated heterogeneous constituents: it poses the paradox of the one and the multiple" (MORIN, 2015, p. 13).

2 The concept of sustainability is defined in the report *Our Common Future*, or Brundtland Report, as one that "[...] meets the needs of the present without compromising the ability of future generations to meet their own needs" (COMISSÃO MUNDIAL SOBRE O MEIO AMBIENTE E DESENVOLVIMENTO, 1988, p. 4).

3 Holistic vision: which understands the universe as an indivisible and dynamic whole.

4 Nonlinear view: guided by cyclical models of flow and information — feedback loops, in which the goal is to establish cooperative relationships that promote the harmonious integration of the systems involved.

One of the first to address environmental issues in design was Papanek (2011), through the renowned publication design for the real world. In this work, the author strongly condemns useless products, which waste natural resources and aggravate the environmental crisis, programmed obsolescence and consumerism, besides dealing with the social and moral responsibility of designers. Maldonado (1922–2018) also denounced the degradation of the environment and criticized the culture of consumption associated with the production of objects with cosmetic bias and low quality. Gillo Dorfles (1910–2018) warned that, in addition to the design of the objects, significant restructuring was also needed in distribution. For Bonsiepe (1978) design is a discipline that, among other skills, should be directed to improving environmental quality. In his work, *Teoría y práctica del diseño industrial*, the author encourages these professionals to commit themselves to society and the future.

The advancement of understanding of environmental issues during the 1990s led to the development of tools and methods that could help understanding, controlling and reducing the negative environmental impacts[5] generated by the production of goods and services. In this field, life cycle analysis (LCA) stands out, which, according to Chehebe (1997), is a technique for evaluating environmental aspects and potential impacts related to a product, involving its entire life cycle, i.e., from the 'cradle' (extraction of raw materials) to the 'grave' (final disposal of the product). According to Pereira (2003), one of the first experiments of evaluation of ecological factors in product development, in the field of design, were conducted through the LCA. The author considers that the concept of ecodesign emerged in this context.

Ecodesign aims to reduce the negative environmental impacts arising from the life cycle of products, through the insertion of environmental parameters, by means of specific tools. The great majority of these are grouped in the so-called design for "X" (DFX), in which "X" is the characteristic that is intended to be highlighted, such as design for assembly (DFA) or design for disassembly (DFD), and so on. For Barbero and Cozzo (2009), besides the design of the object itself, in all its complexity, ecodesign is an opportunity to renew production processes and behavioral habits.

Braungart and McDonough (2013) offer another concept of "life cycle" in *Cradle to Cradle*, published in 2002. Unlike the LCA, which is based on a

[5] Environmental impact is any change in the environment caused by activities, products, or services, and can be "positive" (when it leads to improvement) or "negative" (when it leads to damage).

linear production system[6] "from cradle to grave", the authors propose a circular production system "from cradle to grave", in which all waste is considered as "nutrients" of a new cycle. For the authors, "garbage, pollution, raw products and other negative effects [...] are not the result of corporations doing something morally wrong. They are consequences of an obsolete and unintelligent design" (BRAUNGART; MCDONOUGH, 2013, p. 47). Therefore, they emphasize the importance of developing products in an intelligent way from the beginning, considering their disassembly safely and eliminating the use of hybrid materials that make reuse, recycling or incineration after disposal impossible.

Recently, some authors[7] concluded that to act under sustainability criteria and obtain more effective results, it is necessary to extend the possibilities of innovation beyond the product. From this perspective, a combination of products and services was suggested so that, together, they could be capable of satisfying a user's certain need. Through this approach, entitled Product-Service System (PSS), the consumption of physical products is disconnected from consumer satisfaction by promoting, according to Vezzoli et al. (2018), the generation of environmental, social and economic benefits for all those involved in the process.

In the midst of discussions at the United Nations (UN) Rio+20 conference, the United Nations Environment Programme (UNEP) released an economic model to grow 'green', more and better, called the green economy. This, according to UNEP, provides for the improvement of human welfare and social equality, while significantly reducing environmental risks and ecological scarcity[8]. Although widespread, this approach has also been heavily criticized in several aspects, such as (i) presents abbreviated and misleading concepts; (ii) provides quick and technology-based responses; (iii) needs government subsidies; (iv) induces the 'greening' of the economy; (v) encourages the practice of 'green marketing'. According to Fatheuer et al. (2016), besides spreading a false promise of efficiency, the green economy is not about rebuilding the economy, but about redefining nature, subordinating it to the logic of the market. According to the authors, their great mistake is to correct the failure of the market with more market.

For Johansson et al. (2005), environmental and socio-economic unsustainability is closely related to our centralized, large-scale production model.

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6 Linear thinking comes from the mechanistic, rational model, based on the cause-and-effect relationship, typical of industrial production.

7 GOEDKOOP; VAN HALEN; RIELE; ROMMES, 1999; MANZINI; VEZZOLI, 1998, *apud* VEZZOLI *et al*., 2014.

8 Available from: https://nacoesunidas.org/agencia/pnuma/. Access on: 17 Feb. 2017.

Therefore, they proposed an alternative called distributed economy. This is based on the organization of flexible units that are synergically connected to each other, where certain activities are systematized on a small scale. In this perspective, selected part of the production is distributed to other flexible units where, in parallel, a series of other manufacturing support activities are being organized. For the authors, distributed economy promotes local development, income generation and an increase in the quality of life of the population, the maximization of social capital and collective spirit, as well as a drastic reduction in the use of fossil fuels.

Günter Pauli, one of the founders of the Club of Rome[9], also fights the current economic model, mainly because of the use of scarcity as a foundation for both production and consumption. His proposal is a new business model, called the blue economy, which aims to transform the society from scarcity to abundance. It is a pragmatic redesign, supported by the functioning of ecosystems and the common physical processes of the natural world. The author reminds us that "There is no unemployment or waste in ecosystem. [...] waste of one product becomes the input to create a new cash flow, as in a cascading system. [...] The waste of one is food for another" (PAULI, 2009, p. 1 and 41).

In his publication *The Blue Economy: 10 years – 100 innovations – 100 million jobs*, Pauli (2009) highlights the advantages of connecting and combining seemingly disparate environmental problems with open-source scientific solutions to create solutions that benefit the environment and promote broader social and financial gains. According to the author, it is necessary to learn from the whales how to use energy to move hundreds of liters of blood in millions of kilometers of arteries and veins; with the tuna, how to conserve heat; with the flour larvae, how to produce antifreeze naturally; with the beetles of the African deserts, how to collect rainwater. In Brazil, some concepts and practices of the blue economy have already been used, for example, in the project of the engineer João Alberto Vieira Costa, who carries out research with Spirulina algae to absorb CO_2 from burning coal. In this project, the algae absorb the gas and still produce proteins that can be used in food and can also be used as biofuel.

[9] "Club of Rome" is a nongovernmental organization formed by scientists, economists, entrepreneurs, civil servants, and former heads of state. It was founded in 1968 with the objective of debating issues concerning the future of humanity and the planet Earth, mainly concerning social problems, environmental destruction, and inequality between countries, and has sponsored several reports such as: *The Limits to Growth*, *Mankind at the Turning Point*, *Rio: Reshaping the International Order*, *Goals for Mankind*, among others.

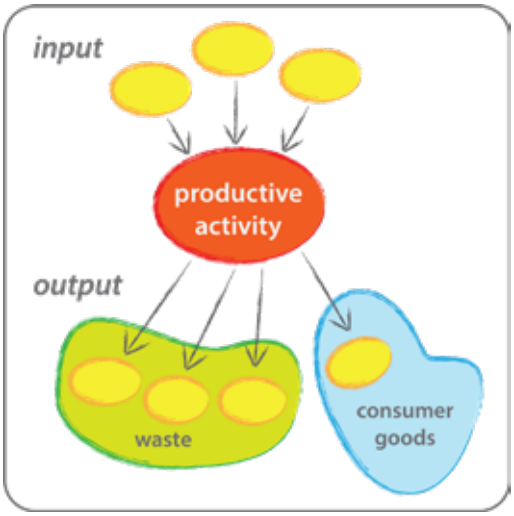
Bistagnino (2009) corroborates with Pauli (2009) reinforcing that it is not necessary to invent anything new, because the solutions are found in the natural systems that surround us. As an example, the author cites the lotus flower, which is cleaned by itself, without the aid of detergents. This natural technology has already been studied and replicated in the field of architecture by a German industry, for the production of varnish that keeps the facade of buildings clean during the rain. Bistagnino (2009) reminds us that, in nature, there is no production of waste, because their systems work in a cascade of nutrients, matter and energy, i.e., the substrates of one system are always used in other system(s), in one or more of the five kingdoms (plants, fungi, animals, Protista and Monera). For the author, the reference model is nature.

It was in this perspective that Bistagnino (2009) developed the methodology of systemic design, characterized by its holistic, or systemic, and nonlinear structure, in opposition to the mechanistic thinking [10] of Cartesian–Newtonian science.

In the mechanistic approach, a complex phenomenon is divided into small parts to understand the behavior of the whole, from the properties of its parts. At this juncture, the focus of designers is restricted to the product and/or service, or to the solution of a specific problem, as they tend to respond to customer demands without question. Such positioning prevents them from perceiving the relationships that can be established between the various parties involved, that is, in a linear manner. Therefore, the scope of a project in the traditional productive scope are the consumer goods, from the classic point of view — the one that will be commercialized in the points of sale or delivered to the consumer. On the other hand, the productive process generates an exacerbated amount of waste, because it considers the consumer goods as the only output of the system, all the others are qualified as waste, without any value, and should be eliminated (Figure 1).

[10] Reductionist-mechanistic thinking was inherited from the philosophers of the 17th century Scientific Revolution, such as Descartes, Bacon, and Newton. Briefly, we can describe this thought as rational, composed of linear chains of cause and effect, based on the analytical method (process by which a complex phenomenon is broken down into small parts to understand the behavior of the whole from the properties of its parts) and in which the world is seen as a perfect machine, typical of industrial production.

Figure 1 – Linear approach



Source: Elaborated by the author.

Moreover, in the systemic approach, the functioning of the system is evaluated as a whole, considering the context and its relations, since it cannot be explained only by the sum of its individual elements separately. As put by Aristotle (384 BC-322 BC) in his work *Metaphysics*, "The whole is greater than the simple sum of its parts".

According to Bistagnino (2009), acting under a systemic vision in design implies designing systems, placing man at the center of the project. This means creating relationships between social actors and the productive reality, according to the environmental, social, economic and cultural[11] context. From this perspective, production allows the creation of economic systems focused on specific and contextualized markets, which go against globalized products, because it recognizes and values the know-how, local resources, identity and community of the territory. It is a new approach that considers the application of natural mechanisms in the productive sector, supported in *Blue Economy.*

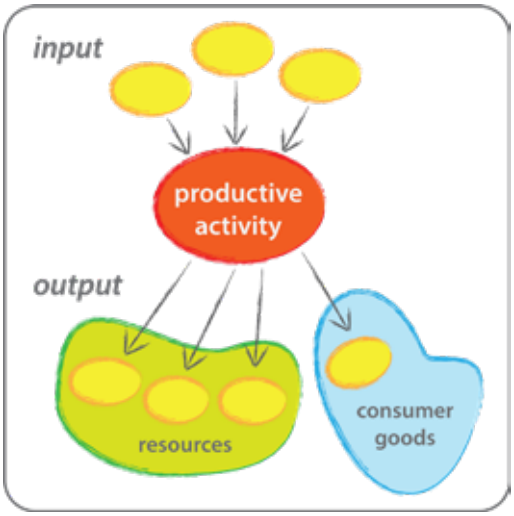
In this model, the various activities of life and production coexist in a participatory manner and have their essential function in the system, none prevails over the other, but each exists thanks to all the others. According to Bistagnino (2009), the practice of systemic design enables, through the positive use of material and immaterial resources, the emergence of a network of new relationships

[11] Culture, welcomed as the fourth pillar of sustainability at Rio+10, is for Boff (2015) a fundamental dimension so that, together with the other three (social, environmental, and economic), development can be considered sustainable.

and an autopoietic[12] macrosystem, composed of all local territorial microsystems, which lead to positive change in the environment and territory. As a result, a new economic-productive model is generated, capable of sustaining itself for long periods. In this scenario, all materials have value, all systems are relevant and strongly interrelated, as well as a network: it is in the set of all knots that their strength and effectiveness reside.

The essence of systemic design resides in a simple principle, but it definitely breaks with our linear thinking: the output (waste or discards) of a productive system must be transformed into input (resources: matter or energy) for other systems, in a systemic and continuous way (BISTAGNINO, 2009). In other words, 'waste' is considered as dynamic elements in production processes, because it is transformed into resources ('raw material') generating value, including economic (Figure 2).

Figure 2 – Systemic approach



Source: Elaborated by the author.

[12] According to Bistagnino (2011), autopoiesis is the quality that all living systems have of continuously self-organizing and redefining themselves according to the relationships (the organization of the system) that exist between the elements that compose it (the structure of the system) and based on the reciprocity that govern the relationship with its environment. An autopoietic system is open to context, its value is greater than the sum of individual contributions. The goals (of equilibrium or evolution of which it tends) will apply to all components. The latter are mutually interdependent, as are all the strategies necessary for the management of the flows of matter and energy, in input and output, the processes of production and endogenous transformation.

It is important to emphasize that this approach contemplates not only the quantity of output of the systems, but, above all, its quality[13], because, as the output of a system will feed others, these must have certain characteristics that fully satisfy it, according to the needs, limits and constraints of the system that will receive it. Therefore, the 'wild' competition between companies, as occurs in the linear approach, gives way to collaboration between the actors involved, because the interest ceases to be individual and becomes collective, since the good of one means the good of all and vice-versa.

The designer, when applying systemic design, does not limit himself to projecting a product, or a line of them, quite the opposite, such artifact is simply a natural consequence of the process and has a specific reason to exist, fully contextualized. In this circumstance, the product is the last of the values to be considered, because the production of an object totally loses its meaning if it fails to attend what is really necessary for the existence of the actors involved and if the values that are important for human life are not taken into consideration in advance. This gives strength to the values correlated to 'being', and not to 'having', reversing the priority of relationships, besides favoring the fulfilment of social and productive demands. Thus, the designer mainly projects relationships, through flows of matter and energy between the productive systems, fundamentally in the same territory.

The objective of systemic design is to promote the rebalancing between production, environment and society, through the development of products, systems, services or processes that tend to zero emission[14]. To this end, its methodology was divided into four stages:

1st) understanding the territory: investigation of the locality in question in the environmental, social, cultural, commercial and productive dimensions, as well as its relations — holistic relief;

2nd) to systematize and analyze the productive systems: verification of all inputs and outputs of local productive activities — conceptual productive scheme;

3rd) to project: development of the material and energy flows between the productive systems of the territory — conceptual scheme of the network of relations between them;

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[13] In the linear system, quality is defined by the norms of the International Organization for Standardization (ISO). In the systemic approach, however, it is defined by the actors involved.

[14] Zero emission is understood as the elimination of all emissions, whether in a liquid, solid, or gaseous state.

4th) to confront: comparison of the current (existing) approach with the systemic one (proposal) — comparative quality-quantitative.

The application of this methodology facilitates the exponential increase in capacity of the territory in question and, consequently, the generation of work and income for the local population. The perspective is a sustainable system.

In this context, a broad understanding of the territory is fundamental for building the network of relationships. Krucken (2009) reminds people that this term, coming from the French word *terroir*, means a territory characterized by interaction with mankind over the years, thus constituting a system of interactions of the natural, physical and biological environment with human factors. For Dematteis (1996), territory means identity, understood as the product of reciprocal interactions within the framework of relations that occur between society and nature. Raffestin (1981) states that territory is a field of forces, a web or network of social relations that projects into space. With the visa, although the distance between the mentions of these three authors is more than a decade, the concept is quite close. For Carmo and Comitre (2010), the notion of territory is built in parallel and as a counterpoint to globalization, because it recognizes, gives visibility, highlights and values local and regional specificities. Although globalization has massified and standardized products, sociologist Otávio Gianni observed that this irreversible process is producing an apparently paradoxical phenomenon: the valorization of local culture (GIANNI, 2004). Albagli (2004) corroborates this approach, since, for him, the winds of globalization and the transformation of the technical-productive base have brought, on the other hand, the revaluation of the territory and provided the territoriality with factors of dynamism, distinction and competitiveness. For Vale (2004), territorial attributes and cultural practices constitute differentiating elements of products and services that, increasingly, have individualized insertion in markets. These new consumption patterns, which open up market spaces, are demanding in both tangible and symbolic quality, associated with the cultural values of the place where the products and services are generated.

The most interesting and innovative aspect of systemic design is that it approaches sustainability in a broader way because, in fact, it is a new economic-productive model based on projects of open industrial cycles, which are formed and self-determined according to their output and input. Moreover, this methodology can be applied in several productive sectors, such as the transformation industry, food chains, services and handicrafts.

As a practical example of this approach, we can cite a doctoral research[15], in which the objective was to apply the systemic design methodology in one of the multiple territories of the Estrada Real (ER), generating several connections between its productive systems, through the recognition of the cultural values (material and immaterial) of the local traditional craftsmanship.

Estrada Real was established in 1999 as one of the most important tourist areas in Minas Gerais, based on the importance of the historical origin of the ancient paths traced by the Portuguese Crown in Colonial Brazil. Besides Minas Gerais, it covers part of the states of São Paulo and Rio de Janeiro. It is more than 1,630 km long that rescue the traditions of the trail, value the identity, the products and the beauties of the region. It can be said that each region of this complex has intrinsic peculiarities that emphasize its quality, and that demonstrate an essential strategic potential for the differentiation and valorization of the identity of its territories.

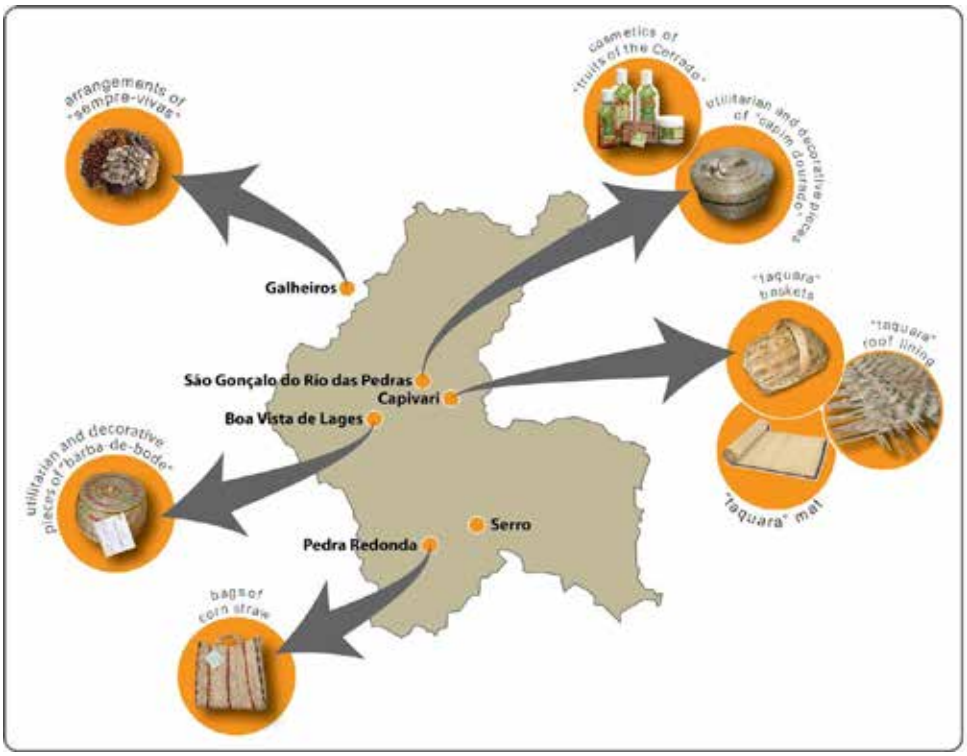
Guided by the methodology of systemic design, the research started from the construction of the holistic relief of the territory addressed in this thesis, called Serro territory. For this purpose, a field research was carried out, in which the craftsmen answered a semi-structured questionnaire and the production sites visited. These actions allowed to understand the operation of the nine production systems, as well as their various problems.

The Serro territory (Figure 3), contemplates the communities of Boa Vista de Lages (Serro village), Capivari (Serro village), Galheiros (Diamantina village), Pedra Redonda (Serro village), São Gonçalo do Rio das Pedras (Serro district) and the city of Serro. The artisan productive systems involved cosmetics[16] of Cerrado fruits (macaúba, amesca, mutamba and pacari); utilitarian and decorative pieces of *barba-de-bode* grass; utilitarian and decorative pieces of golden grass; bags of corn straw; arrangement of everlasting flowers; basketry, mats and taquara roof covering.

[15] Study carried out as part of the doctoral research conducted by the author, with Politecnico di Torino between 2013 and 2016, entitled "*Approach of the systemic design in material and intangible culture of Estrada Real: territorial Serro case*". *C.f*: PÊGO, 2016. Available at: https://doi.org/10.6092/polito/porto/2644209. Access on: 18 June 2017.

[16] The cosmetics are: shampoo, conditioner, soap, and massage oil.

Figure 3 – Serro territory



Source: Elaborated by the author.

Among the main problems, which, according to the systemic design, are considered as levers for change, are highlighted: 1) long distance transportation — acquisition of components for the production of artifacts in other regions, resulting in the generation of work, income and taxes for those regions to the detriment of the site, in addition to all the adversities widely spread over the use of fossil fuels; 2) use of chemicals — causing various negative impacts for mankind and the environment; 3) very little use of local resources — lack of knowledge of the intrinsic characteristics and potentialities of the resources, minimizing too much the production and its proceeds; 4) the imminent "death" of material culture (handicraft) and immaterial culture (know-how) in the region, because, according to the craftsmen, young people are not interested in continuing these activities, since they do not offer sufficient financial return. This causes migration to the big urban centers, generating another series of problems, well known to all.

Based on the analysis of this context and in-depth studies regarding the intrinsic characteristics of natural resources and local know-how, material and energy flows were projected between the production systems, both existing and proposed, thus emerging in the various new activities and products.

Finally, when confronting the current approach and the systemic proposal, it is possible to state that the result was positive and particularly surprising. On the productive system of the cosmetics of macaúba, for instance, there was one activity and four products. With the systemic design approach, 14 new activities and 24 new products emerged, resulting in an increase of 1,300% of activities and 500% of new products.

The results of the other productive activities involved in the work were similar: 1) Amesca: 900% increase in activities and 1,000% in consumer goods; 2) Mutamba: 1,300% increase in activities and 470% in consumer goods; 3) Pacari: 1,000% increase in activities and 430% in consumer goods; 4) Beef-goat grass: increase of 500% activities and 120% consumer goods; 5) Golden grass: increase of 500% activities and 38% consumer goods; 6) Corn straw: increase of 400% activities and 1,300% consumer goods; 7) Evergreen: increase of 1,000% activities and 430% consumer goods; 8) Taquara: increase of 500% activities and 430% consumer goods.

In this context, the creation of a Coexistence Center in a work cooperative system was idealized, which is concomitantly a place of work that: a) work for the artisans, offering the opportunity to exchange experiences and knowledge, since currently each one works alone in their residence; b) training for young apprentices, ensuring the perpetuation of know-how; c) training for the artisans themselves, where they can learn new techniques and/or improve the current ones; d) development of new products and/or services, with or without the help of designers; e) holding workshops and lectures that involve culture, craftsmanship and sustainability; f) experience tourism, where craftsmen can offer tourists the opportunity to experience the entire production chain of local craftsmanship pieces, valuing both the activity and the territory; g) shopping center, where all craftsmen can acquire more adequate inputs at a lower cost depending on the volume of purchases; h) stock of products and inputs; i) commercialization of consumer goods.

In this sense, a question that has attracted much attention during the study in the Serro territory was the extraordinary potential that the region has for the use of its native plants in the development of phytotherapeutic and phytocosmet-

ic products, because the Serro regions are in the second largest South American biome — the Cerrado. This is certainly a field of immense possibilities.

For this, it is believed that one must, first of all, involve the interested people of the community, who have the will to belong to the proposed new system, because they are precisely the ones who will act under such approach to generate a cohesive relationship network. From the formation of this network, it is important to develop partnerships with: universities, in order to generate an interdisciplinary research group; city halls and local politicians, in order to verify the possibility of donating land for the construction of this center, besides the search for fiscal incentives; agencies that promote research as well as scientific and technological innovation, aiming at part of the financing of the project; the Instituto Estrada Real[17] as a structuring and logistic support.

As could be observed, the systemic approach entails: i) in the economic sphere (increasing activities, jobs and income generation in the community); ii) in the environmental sphere (sustainable management of natural resources); iii) in the cultural sphere (valorization of local culture and know-how); iv) in the social sector (improvement of the quality of life and maintenance of the inhabitants in their territory).

In the academic field, it is possible to foresee, in the short/medium term, a distinct approach to problems in the design field, application of the methodology in research and extension projects in Brazil. dissemination of this methodology in the country. In the medium/long term, the creation of a research center dedicated to systemic design at the school of design of the Universidade do Estado de Minas Gerais (UEMG) has been projected.

It is highlighted that, as this study has a defined and delimited theme as a result of a doctoral thesis, many possibilities are open, both for continuity and deepening, and for the development of new projects with a systemic approach in diverse territories and/or other productive sectors.

ACKNOWLEDGEMENTS

The author thanks the Fundação de Amparo à Pesquisa do Estado de Minas Gerais (FAPEMIG) for granting the Ph.D. scholarship, the Universidade do

[17] "Created in 1999, the Instituto Estrada Real aims to organize, foster and manage the Estrada Real tourism product. The Institute is linked to the FIEMG System and has a multidisciplinary team, which has made the destination recognized in Brazil and worldwide". Available at: http://www.institutoestradareal.com.br/estradareal. Access on: 18 June 2017, our translation.

Estado de Minas Gerais (UEMG) and Politecnico di Torino (POLITO) for the opportunity.

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