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Systemic Software: An IT Network at the Service of the Environment

Clara Ceppa, Politecnico di Torino, Italy

Abstract: Current production processes do not fully exploit natural resources and discard a significant percentage. To restrain this phenomenon we need to create, in collaboration with Neosidea Group, an instrument for making the changes needed on the level of the management, organization and procurement of raw materials and energy. We can start seeing the importance of creating an IT instrument based on the concept of an open-loop system that can help companies, according to their business purpose or geographical location, to organize themselves into "ecological networks" to achieve production that moves towards zero emissions by means of sustainable management and valorization of waste: by following the first principle of Systemic Design, waste (output) of one productive system can be used as a resource (input) for another. Linked enterprises could reach a condition of reciprocal advantage by allowing the reutilization of the materials put out by their production processes; profits can be obtained from the sale of these outputs. The constant exchange of information and sharing of knowledge between the players involved allows a continuous systemic culture to spread, along with the concepts of prevention and the ongoing improvement of the environment. Essentially I'm proposing an IT network at the service of the environment, a web that speaks to the earthly roots of humanity and the deep need for a revived attention to nature and the resources it offers. The huge amount of data obtained by using Systemic Software is a precious asset and a vital platform for designer, scholars of the environment, researchers, ecologists, public agencies, local administrators and, obviously, for entrepreneurs, who will be able to work in a more sustainable way. The combination of the systemic approach and this technological support instrument improves understanding that an effective environmental protection is not in conflict with the economic growth of enterprises.

Keywords: Systemic Design, Software Design, Output-Input, Sustainable Development, New Flows of Materials/Resources

Introduction

WE ARE LIVING in a time when human impact (Cottrell, 1978) on the natural environment has reached unprecedented ferocity. It is no longer just a matter of isolated and circumscribed phenomena. The issue of the environment has become central, which is where it belongs, in the vicissitudes of human life. It certainly was not discovered yesterday, but the pressure of humans on natural resources in the last half-century has become more intensive (Boggia et all. 2003) and widespread than ever.

In all types of productive activity some of the resources used are returned to the environment in a random and disorderly manner in the form of gaseous or liquid effluent. This problem has taken on increasing importance in the past few years for several reasons:

1. an intensive exploitation of natural resources;
2. an increase in waste;

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3. the qualitative evolution of waste products during the transition from an agrarian society to an industrial one, where a lot of waste are difficult to eliminate;
4. the energy crisis;
5. ineffective recovery operations.

Faced with the incapacity to introduce new methods, we are still using dumps, which should nonetheless be considered a transitory and temporary solution until we can use technologies apt for recovering the various types of elements contained in the refuse. To deal with this problem properly and solve it optimally, we must analyze it from a different perspective that will highlight how our current production activities throw away most of the resources they take from nature. Let's look at the case of paper. When we extract cellulose from wood to make paper, we use only 20-25% of the trees while the remaining 70-80% are discarded as waste (Capra, 2004), as Pauli maintains, the time has come for us to stop expecting the land to produce more and to start expecting humans to do more with what the land produces (Pauli, 1996).

In the past few years the concomitance of the energy problem with the need to save no-renewable resources and an increased sensitivity to environmental protection, a new philosophy has spread which favours the production and use of goods which raises the status of so-called waste products to materials worthy of proper, rational and targeted management to lighten the polluting load and allow direct or indirect recovery of the recyclable and energy elements.

A Design Methodology to Reduce Human Pressure on the Environment

Today harming the environment, lacking resources and the myth of unlimited development have forced us to think about and reconsider the role of designer in society. In addiction in this situation more and more consumers begin to purchase product in a conscious way and buy more environmental friendly products (Paulesich, 2008). Designers are faced with the challenge to design and realize ecologically sustainable communities, products and services that do not oppose the system of the natural world: the productive process must turn to Nature, the system par excellence, to understand the complexity of a system made up of relations between different beings and the continuous evolving flow of matter.

Moreover in Nature there is no such thing as waste and even surpluses are metabolized by the system itself. If these conditions, which are fundamental for a living system, are adopted in production, they will favor the development of a zero-emissions production precisely because the waste (output) of one process is used as a resource (input) for another production process.

Observing Nature and imitating it means humbly recognizing our dependency on it and our non-priority role in the web of life in which we interact, as a specific individuality, with an enormous number of living systems. Humans are only one part of that complex fabric of interactions which is Nature (Barbero et Campagnaro, 2008), live within it and depend on it. This attitude of seeing Nature as a model and a guide has been adopted today by systemic designers who study patterns and flows in the natural world and attempt to incorporate (Capra, 2004) those principles to design and production methodologies.

We must apply our ecological knowledge and know-how to the fundamental redesign of our technologies and social institutions in order to fill the gap that today separates human

design from the ecologically sustainable systems of nature. But to enable the building of sustainable industrial societies, the principle of eco-design and the (re)circulation of materials (Capra, 2004) should extend beyond the sphere of organic waste. To do that we must extend our gaze to the entire production process and see it in its entirety, i.e. not by single phases; therefore the overall equation of production must also include the variable represented by the resources generated as byproducts or scraps (Bistagnino, August 2008), which otherwise would end up not being used.

These ecological assessments must be followed by an economic assessment: the aforementioned residues contain a significant amount of intrinsic properties and potentials that were not exploited but they were dumped or drained off into sewers and water courses. However, the resources saving, viable through a recovery of byproducts (Nicholson, 1970), leads to the enrichment and diversification of the industrial apparatus. We need to retrieve the cultural and practical capability to delineate and program the flow of material from one system to another in a continuous metabolization that reduces ecological impact and generates a notable economic flow (Bistagnino, August 2008); currently the scraps of production processes are only an economic and environmental cost.

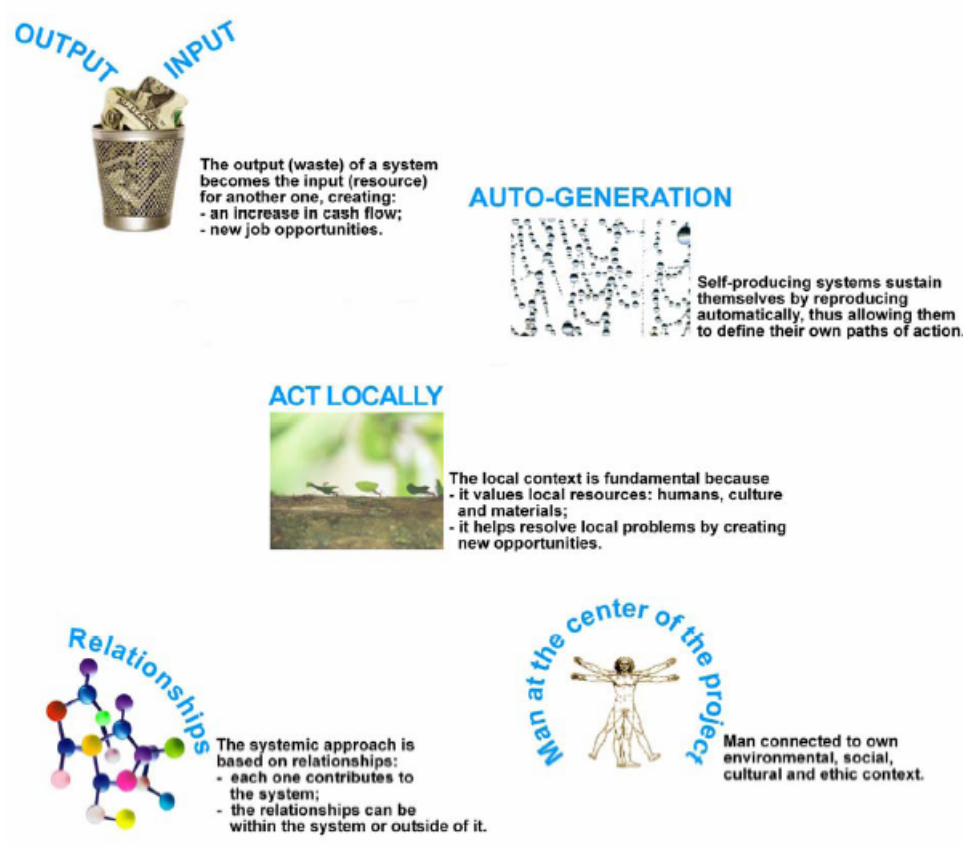

Figure 1: Systemic Design Guidelines

According to the first principle of Systemic Design (Bistagnino, 2009) the outputs are enriched with new value and become a resource available to be in the manufacture of new products closely associated with the local skills.

In this sense all in industrial production must reduce the use of nonrenewable materials and evolve toward less energivorous processes, making uncontaminated outputs that can be reused for their qualities.

By adopting the Systemic Design methodology, the productive systems are observed on the basis of their induced internal and external relations, such as procurement and conversion of the material, management of the output on a territorial level, the use of energy, control of emissions. The systemic approach attentively manages natural resources and the environment and conserves our natural heritage for future generations. A radical change is needed in our perceptions, ideas and values; the economy, and industry, must operate in harmony with nature (Bani, 2008).

Systemic methodology proposes a new approach that stimulates people and companies to reduce all forms of waste and helps valorize the remaining outputs by giving them a new economic and legislative value. This way not only the so-called waste products are elevated to a status of materials worthy of proper, controlled and more sustainable management, but they can "move" within the production chain with new positivity and dignity.

Systemic Software to Generate New Ecological Networks

In order to build sustainable industrial societies, it's therefore necessary to help the industries to organize themselves into ecological groupings: to do that we need to create an instrument for making the changes needed on the level of the management, organization and procurement of energy and resources. Only in this way can achieve a society based on a life cycle of products, consistent with environmental needs and able to meet human needs (Lanzavecchia, 2000) while consuming few resources. We can start seeing the importance of creating an IT instrument for study and analysis based on the concept of an open-loop system that can help neighbor companies, according to their business purpose or geographical location, to organize themselves into "ecological networks" to achieve production that moves towards zero emissions by means of sustainable management and the valorization of waste. If the systemic approach is a methodology capable of turning a cost into a benefit, a waste product into a resource, Systemic Software is an instrument that can support analysis of the system approach applied to a local area and define the possible interactions apt to create a network, i.e. a system that can feed and support itself, of companies that can exchange resources and competencies with consequent gain for all the operators involved in the network of relationships.

In specific terms we propose the definition, design and realization of a tool for processing information based on evolved technological systems that can acquire, catalog and organize information relative to the productive activities in the area of study, the outputs produced and the inputs required as resources; this data is acquired and organized in terms of quantity, type, quality and geographical location on the territory. All the data are correlated with each other by means of a complex logic.

The logic and the algorithms that intervene on the acquired information serve to normalize the structures, allowing them to be interlaced and evaluated by evolved technological instruments which serve to render the information in an intelligible and intuitive format for all of those who interface with the Systemic Software.

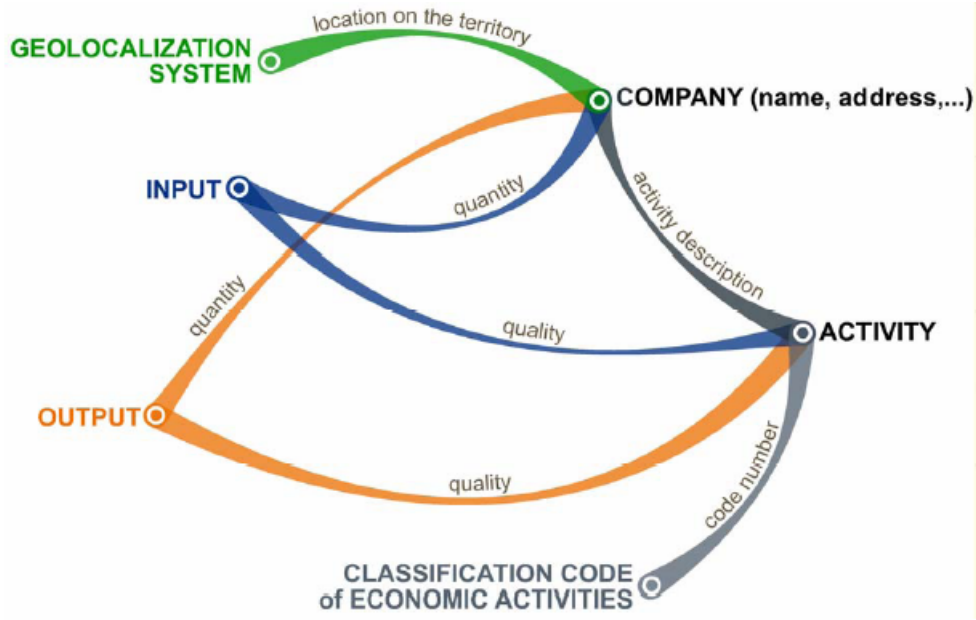

Figure 2: Flow Chart of Software Architecture

The consultation of the system was designed by following the systemic approach and made usable by means of Web 2.0 technologies; this approach has made it possible to publish an interactive web portal as a facility that can be used by operators who want to consult it and interact with it.

We choose to use web 2.0 technologies cause it enhances the user's role and consequently the social dimension of the network: Tim O'Reilly argues that the network's value lies not in technology but in content and services, and that the strength of the network is represented mainly by its users. The enhancement of the social dimension of the network, through instruments capable of facilitating interaction between individuals and the user transformation into active creators of these services, allows that the quality of the offered services improves as the number of users involved in their use.

The huge amount of data obtained by using Systemic Software is a precious asset and a vital platform for scholars of the environment, researchers, ecologists, public agencies, local administrators and, obviously, for entrepreneurs. The last mentioned actors will be able to work in a more sustainable way.

The functions of the systemic software are fourfold:

- producers of waste would be able to determine which local companies could use their outputs as resources in their production process;
- it tells input-seekers which companies produce outputs they can use as resources;
- it informs different producers about new business opportunities on the local territory that have previously remained hidden;
- it is an efficacious instrument for evaluating the entire production process and becomes an instrument for providing feedback.

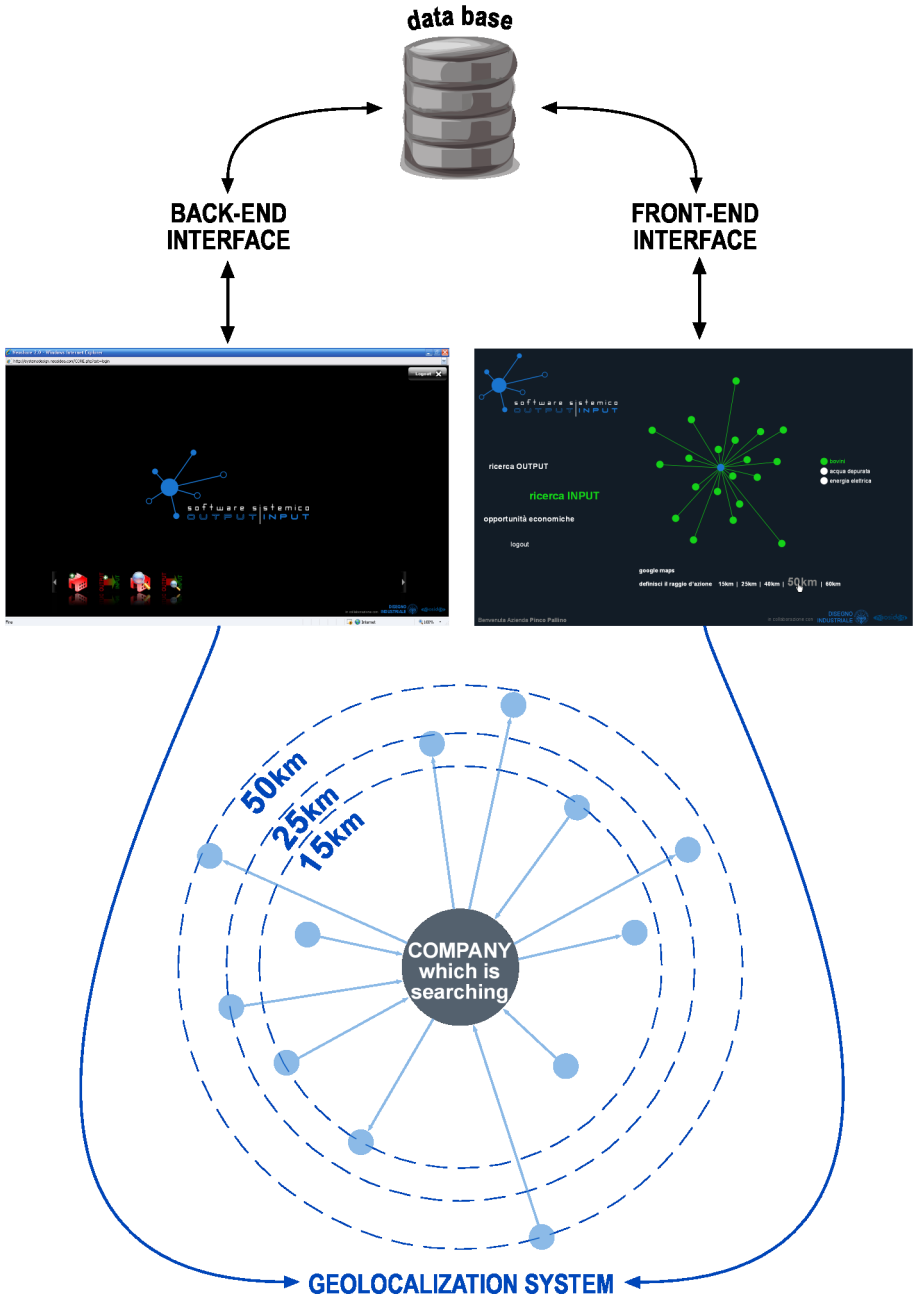

Figure 3: Web 2.0 Interfaces Linked to Geolocalization Function

Therefore this system can give useful and reliable information regarding one's current production process: if you enter the type of waste produced by your company as a search cri-

terion, and the Software gives no results for possible reutilization of your outputs, this means your current production process makes waste that cannot be reused or recycled. It means your company produces items by using inputs and processes that do not comply with the vision of an open system. Therefore we have observed the need to implement certain changes within the production line, for example to reassess current inputs and substitute them with others that are more environmentally sustainable.

The tool, according to the project, satisfies the following requirements:

1. projection of information and tools developed through joint diffusive and interactive instruments;
2. ability to connect different actors (public agencies, entrepreneurs, researchers, etc) on a territory;
3. ability to link production processes with materials according to systemic logic;
4. geographic location of industries on the territory;
5. acquisition of external database to manage the types of materials and production activities;
6. ability to abstract and aggregate data in order to identify new flows of materials and economic opportunities for people involved into the network of relationships.

To make operating the fourth item the processing system, developed in collaboration with Neosidea Group, was also supplemented with the function of geo-locating business is and materials and this provides a solution and that gives not only information regarding new areas of application of the outputs but also determines with precision and localizes by territory the flows of material within a local network whose nodes are represented by local companies. By using the geo-location function, the system can ascertain which local activities are situated within the range of action (e.g. 60km or 100km) defined according to the search criteria. Then it positions them exactly on a geographical map to show the user which companies can be part of the network of enterprises which enter into a reciprocal relationship to increase their own business and maximize their earnings through the sale of their outputs and the acquisition of raw materials from other local production activities.

The greatest innovation offered by the Systemic Design approach and the Systemic Software, besides its instrumental value, is its ability to open the minds of producers and make them aware that: the problem of waste “disappears” if complex relations are set up in which companies can become the nodes of a network along which skills, know-how, well-being, materials and energy can transit; an overhaul is made of everything that occurs upstream of the waste without delegating responsibility to other operators.

New Flow from Cattle Breeding Case Study

I will illustrate a production chain that starts with a cow farm and ends with the retail sale of final products, passing from the milking phase to slaughter. Thanks to the development of a structured implementation logic based on the systemic vision, the information processing instrument or systemic software, is able to provide further information to set up new production chains and new flows of materials and services in favor of all the businesses who join the initiative thanks to a constant updating and comparison among the systemic logics for reusing materials, local productive activities and the territory itself.

The starting point is to analyze the actual process and underline some critical points: according to the analysis conducted on the various phases of the process, it appeared that the phases are considered separate from one another and follow a linear course where the waste is seen as something to throw away and not as a resource. By applying the systemic methodology, and using Systemic Software, it was possible to establish new ways to use these resources and create local flows of material. The outputs from the cow farm were sent to other production enterprises: the water with urine content was sent to water treatment facilities to be treated. The manure, sawdust and urine were used in biogas production plants which produce methane and sludge that are excellent ingredients for high-quality compost for farming purposes. The outgoing material of the milking phase is currently thrown away but the water contains a certain percentage of milk. This resource is rich in nutritional value if managed systemically and can be used to feed freshwater fish.

Numerous critical points were also found in the slaughtering process. Particularly noticeable was the problem of the squandering of certain fundamental byproducts with a high biological value, e.g. the blood (Ganapini, 1985). In the new web of connections blood is used for the production of soil and natural flower fertilizer. Blood traces were also contained in the water sent to treatment plants and plant-filtering processes. The remains of the meat and some of the animals' organs and entrails give a major contribution to raising worms, an essential food for raising quail. Quail eggs are high-quality food products. The last phase of the chain, the retail sale of the final products, produces outputs, though certainly in lower quantities due to the small-scale operations of the butcher. However they are not of lower quality. Animal bones and fat can be used by companies that process and conserve food products.

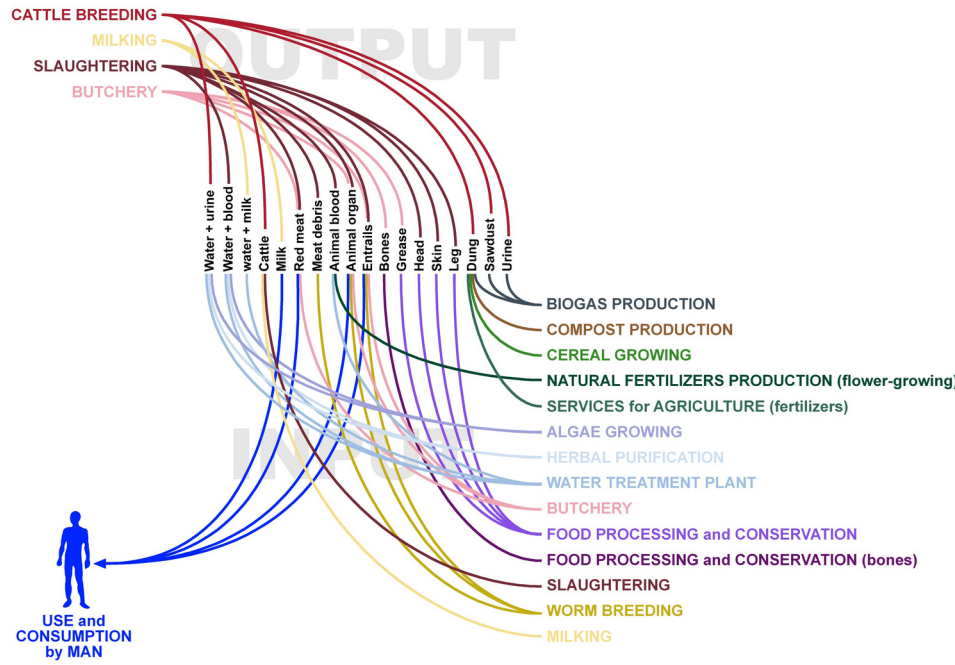

Figure 4: New Connections Generated by the Tool

Conclusion

The proposal of a technological instrument of this type facilitates the raising of awareness by the various actors on the territory, on various levels of expertise, about the numerous possibilities offered by the systemic culture, in particular Systems Design applied to a productive territory. The study therefore aims at making knowledge about the instruments offered by the systemic approach explicit and more accessible. By sharing knowledge and experience through networks and design-driven instruments we can offer an interpretive key for understanding its benefits to the environment and the economy, benefits generated by a possible transition towards a systemic nonlinear type of productive and territorial culture.

The network and instruments offer concrete possibilities to transform waste into materials worthy of appropriate, rational and targeted management, and more importantly, profitable reuse. This reinforces the concept according to which an efficacious protection of the environment is not in conflict with the economic growth of businesses.

Essentially we are proposing an IT network at the service of the environment, a web that speaks to the earthly roots of humanity and the deep need for a revived attention to nature and the resources it offers. The advantages of such an instrument are that they: improve usability, facilitate use and satisfaction, expand the potential area of users, improve the use of technological resources and local resources, raise the quality of life of society whose health depends on the way it relates to the environment hosting it, valorize the potentialities of the local territory and of the economy itself. The proposal of a technological support of this type arose from the consideration that this "virtual" web allows us to react more rapidly when confronted with environmental issues, involve different areas of users, and have a positive influence on decisions and actions taken by public institutions as well as on producer companies.

The greatest innovation offered by this approach and instrument consists of raising the awareness of producers that the problem of waste can be solved by activating complex relations in which the outputs of one productive process connect the nodes, which are local companies, of a network in which know-how, well-being, material and energy transit.

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About the Author

Clara Ceppa
In these years Dr. Clara Ceppa focused her attention on the current and increasing problem of waste, that derives from different productive processes; actually we know the typology of waste but not the own intrinsic potentialities and the new fields of application. Her research allowed to identify not only new areas of application of output, like input for others productive processes, but also to determine with precision and localize by territory the flows of material within a complex local network in a well-defined territorial context. The research distinguishes itself by the realization of a software, that can process the acquired data and create new relations and connections between different productive activities to favor a sustainable development of local resources and waste. She is researching also about food-packaging and eco-friendly packaging.

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