Systemic Design for Food Sustainability
Interpretation of real cases and reflection on theories

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Abstract

This paper investigates how systems and complexity theories applied to the food sectors can contribute to wellbeing and decent life for all, maintaining the global ecological capacity for future generations. The reflections on this topic come out from the author's last ten years of field experiences, mapping the significant problems directly faced in the design and implementation phases. The wide range of analysed projects allows their interpret at theoretical level in order to define the new frontiers of systemic approach in food design toward more sustainable communities that produce and consume food in conscious and responsible way. The purpose is to give empirical and theoretical contributions with developed, developing and transition perspectives.

Introduction

The food topic comes highly over the people's lives (everyone can daily have experience on it), however the level of real awareness on it is very low. A healthy and safe feeding is the key element to ensure a sustainable development for the entire planet and for the diverse territories. The theme of food is one of the major challenges for the near future, indeed it involves every aspect of our lives: a correct behaviour in relation with the territory means respect for the people and their health. In that sense food can be an "index" for the sustainability of community, taking inconsideration many different elements.

The environmental sustainability of food involves its entire life cycle and its connected complex system. The four phases of food's life cycle are: production, transformation and conservation, transportation, consumption and disposal.

In food production phase, the hegemony of intensive farming and livestock have caused huge social, ethic and environmental debates (Shiva, 1993), like the consideration for animals and ecosystem exploitation, workers' rights defence and care of consumers health. These needs of huge amount of food force some risky adulteration in production, like the massive use of chemical pesticides or the use of organisms genetically modified, with the consequences related to the food security.

The market request for ready-to-eat, long-lasting meals has determined the actual food processing system: frozen and long-lasting meals are worldwide sold in huge shopping mall. One of the social consequences of this kind of market request is the lost of cultural and geographic peculiarities. The transformation fakes and flattens out the appearance of the food that everybody eats. Food's flaws disappear and it's not that rare to get to the phenomena of sophistication and food fraud. Other aspects to be considered in the transformation phase are the high level of industrialization in all the processes, with great attention in the sanitation of food (Collins, 2010), that is not bad from itself but should be managed in a sensitive way in case of high migration fluxes like nowadays.

Processed foods are moved among the five continents following fixed roads defined by a highly vertical distribution system. In order to assure to the food a fictitious freshness and a good shape despite the long time and space transportation, sophisticated systems are required. In that situation, the large-scale distribution and retail have a big power and authority.

For sure, the consumer has a crucial role because decides what to eat and consequently what the food system should produce. The main problems related to the consumption phase of food are the loss in the perception of food seasonality, and in the culinary traditions, furthermore people are asking more and more for low-cost food. At global level the contradiction between

obesity and malnutrition should be faced in a long term and serious programme for the health and wellbeing of local communities.
Last, but not least, is the disposal phase: every year one third of the food intended for human consumption is thrown away. The struggle against food waste and losses is one of the challenges of this century.
The change in human diet habits can have the power and the responsibility to modify the entire system. The increase of awareness in the personal food and nutritive choice will lead that change. A great possibility consists in the promotion of new behaviours and new model of consumption: re-discovery the culinary practices of waste reuse, well known to the previous generations, it becomes essential to create new ethical systems to share the nourishment in excess as well as to avoid upstream the food over-production.

Background and methodologies
The theories about complexity help the management of the entirely food systems and the design approaches help the planning of different divergent elements.
The complexity theories evolved on the basis that living systems continually draw upon external sources of energy and maintain a stable state of low entropy, as the physicist Erwin Schrödinger asserted after the WWII, on the basis of the General Systems Theory by Karl Ludwig von Bertalanffy. Some of the next rationales applied those theories also on artificial systems: complexity models of living systems address also productive models with their organizations and management, where the relationships between parts are more important than the parts themselves. Generative science is the interdisciplinary and multidisciplinary science that explores the natural world and its complex behaviours as a generative process. Generative science shows how finite parameters in the natural phenomena interact with each other to generate infinite behaviours. This science explores the natural phenomena at several levels including physical, biological and social ones. Generative science originates from the monadistic philosophy of Gottfried Leibniz, at the end of XVII century, in which monads are the ultimate elements of the universe: “substantial forms of being”. It was further developed by the neural model of Walter Pitts and Warren McCulloch, in the early XX century. The development of computers laid a technical source for the growth of the generative sciences. However, the cornerstones of the generative sciences came from the work on cellular automaton theory by John Von Neumann, in the 1940s. The generative sciences were further unified by the cybernetic theories of Norbert Wiener and the information theory of Claude E. Shannon and Warren Weaver in 1948. They built the idea of unifying the physical, biological and social sciences into a holistic discipline of Generative Philosophy under the rubric of General Systems Theory (GST) by Ludwig von Bertalanffy, that in 1954 established the Society for the Advancement of GST with Anatol Rapoport, Ralph W. Gerard, Kenneth Boulding. He stated that “*a system is a set of unities with relationship among them*”, so it is evident the relational aspects among the several parts and the global essence of the whole system. Contemporary ideas from systems theory have grown within diversified areas, exemplified by the ecosystem ecology by Eugene Odum, the living systems by Fritjof Capra, the organizational theory by Peter Senge, the interdisciplinary study about areas like Human Resource Development by Richard A. Swanson and insights from educators such as Debora Hammond. As a trans-disciplinary, inter-disciplinary and multi-perspective domain, it brings together principles and concepts from ontology, philosophy of science, physics, computer science, biology and engineering as well as geography, sociology, political science, psychotherapy and economics among others. Generative science had an important influence by the development of the cognitive sciences through the theory of generative grammar by Noam Chomsky, in the late 1950s. In 1977 Ilya Prigogine received the Nobel Prize for his works on self-organization, conciliating important systems theory concepts with system

thermodynamics. It has advanced in the field of the autopoiesis by Humberto Maturana and Francisco J. Varela and in self-organization by the works of Stuart Kauffman, in 90s. Generative scientists are working towards further developments and new frontiers. Latest and emerging directions in these sciences include the computer simulations of complex social process and artificial life (i.e. Boids). Treating productive organizations as complex adaptive systems allows a new management model to emerge in economical, social and environmental benefits (Pisek & Wilson, 2001). In that field, Cluster Theory (Porter, 1990) evolved in more environmental sensitive theories, like Industrial Ecology (Frosh & Gallopoulos, 2989) and Industrial Symbiosis (Chertow, 2000). Those theories are the lens with which the Systemic Design research team (SDrt) at Politecnico di Torino faces and analyses the different complex situations of the presented cases.

The design thinking, as Buchanan said in 1992, means the way to creatively and strategically reconfigure a design concept on a situation with systemic integration. This needs a strong inter- and trans-disciplinarity during the design phase (Fuller, 1981), with the increasing involvement of different disciplines including urban planning, public policy, business management and environmental sciences (Chertow, Ashton, & Kuppali, 2004). The design thinking is the way used by SDrt to formulate the new projects presented in this paper.

Systems and complexity theories and design thinking redesign a pretty new discipline (Jones, 2009): the Systemic Design. All the presented cases are designed and implemented following the Systemic Design approach by the SDrt in the last decade.

The Systemic Design approach looks at making better use of material and energy flows in order to model production and energy systems after nature (Bistagnino, 2009). Material and energy loops are open in order to decrease environmental impacts and resource depletion. Living systems are “open” in the sense that they continually draw upon external sources of energy and maintain a stable state of low entropy that is far from thermodynamic equilibrium (Shrodinger, 1946). Many industrial ecosystems have come about ad hoc for better business, while others have been facilitated through external actors. However, as these theories and ventures may be innovative for the industries, they are still no more than solving problems that arisen from environmental pressure and economical revisions. Systemic theory is the study of how complex entities interact openly with their environments and evolve continually by acquiring new, “emergent” properties (Heylighen et al., 2000). Rather than reducing an entity to the properties of its parts or elements, systems theory focuses on the relationships between the parts that connect them into a whole. Complex systems are generally dynamic, nonlinear and capable of self-organization to sustain their existence. This approach is patterned after the self-organizing behaviour of living systems. This type of reasoning leads to the “Gaia hypothesis”, which claims that the world is a single giant organism (Lovelock, 1988). Systemic Design approach proceeds with constant awareness of related systems, boundary conditions, external effects and potential feedback. It plans entities with inherent “resilience” by taking advantage of fundamental properties such diversity (existence of multiple forms and behaviours), efficiency (performance with modest resources consumption), adaptability (flexibility to change in response to new pressures) and cohesion (existence of unifying forces or linkages) (Fiksel, 2003).

Experiment design

The real cases analysed in this paper include a wide range of food sectors and different local contexts, so it is possible to interpret them in a more theoretical level in order to define the new frontiers of systemic approach in food design toward more sustainable communities that produce and consume food in conscious and responsible way. The purpose is to give empirical and theoretical contributions with developed, developing and transition perspectives.

In the last ten years the SDrt in Politecnico di Torino, in which I am active part, have been working a lot in practical application, in order to have field experiences of first hand reliability, so now we can interpret the results of real cases with important considerations also at theoretical level. In this occasion, I would like to underline especially the wicked problems that we faced in each project because they help us to learn and to better navigate the new frontiers.
First of all, I group the cases in three main macro-subjects in order to underline their peculiarities and the different scales: company, community, and territorial context.
The company scale includes the cases where the Systemic Design approach works in tight contact with business activities. One case is "EN.FA.SI." (co-funded by the Piedmont Region) in which the value chain related to the PGI bean (Fagiolo Cuneo) endorses the entire area involving the small family producers and the local SMEs. The second one is "Fondo Noir" (funded by Lavazza company) in which the spent coffee ground from the coffee bars in the metropolitan city centre is collected by cargo-bike in order to generate many new businesses. The third one is with one SME in Piedmont Region, Italy (Agrindustria srl) for the development of the surrounding through the redesign of the material and energy flows of the company. The last one is related with a big French company: Poult. It produces biscuits and the aim of the project is the definition of new territorial recipes that give value to the resources (and waste) of the local area.
The community group creates a network of subjects, initiatives, experiences, in order to define a food governance integrated with the territory and a mutual enhancement of daily food supply/consumption. One case is "Fa bene." (runs by Plug and Liberi Tutti no-profit associations, co-funded by Snodi, Caritas, and Compagnia di San Paolo), it collects the food surplus and donations in street markets for redistributing it to families with economic problems, in return of practical actions for the local community. The second one is "HFW" (Hospital Food Waste), that gives short and long time solutions to reduce the food waste in the distribution of meals in the hospitals and to redistribute the food no corrupted and no eaten to poor local families. "Dégust'Alp" (co-funded by the European Commission) and it is a communication campaign to increase the knowledge on local food products with high quality and to promote their consumption directly in companies' canteens.
The territorial context cases include larger areas of intervention and implementation in order to obtain Local Economic Development (LED). The first case is Val Sangone in Italy: breeders and farmers have endeavored to put in place their wits looking for a no longer confrontation with the homologated economy but with the local area. The identity of the valley is therefore bounded to the products and knowledge of its community. The second case is Ahuacuotzingo in Mexico, where the Systemic Design Approach is applied to the activities of five farmers who want to be able to improve their quality of life, starting from the resources of their own territory. The third case is Lea Artibai in Basque Country (Spain) where the region is analysed and their activities developed in order to a increase the quality of life starting from food sector and ending with the tourism. The last one is Saftica in Romania where a small village was redesign with its new flows of materials and energy.

Results
Then, from all these cases a map of significant problems can be designed and they can give a reflection on the possibilities for future ways to overcome them.
The main problems/opportunities related to the projects included in Company's group are:

- many partners equally important (different priorioties and timing);
- small companies without R&D department are strictly focus on economic feasibility in short terms;
- big companies with strong core business and long history are reluctand to change;

- the interest of the system overcomes the single interests of partners;
- many disciplines to coordinate and to push together;
- long process of implementation.

The main problems/opportunities related to the projects included in Community's group are:

- many partners equally important (different priorioties and timing);
- shift from subsidiarity to fair profit;
- many legislations to take into account;
- long process of implementation.

The main problems/opportunities related to the projects included in Territorial context's group are:

- many partners equally important (different priorioties and timing);
- primary interest and involvement of public administration;
- many legislations to take into account;
- long distance to coordinate the long process of the implementation phase;
- many disciplines to coordinate and to push together.

These considerations are often the same in the three groups so we can redefine the influences of these factors in a different map with three main topics: keystone players, design and implementation and economic feasibility (figure 1).

figure 1: map of the problems/opportunities observed in real food case studies.

Conclusion

Finally, all these cases show how the complexity of food systems impacts the simplicity of the everyday life solutions. Its role is crucial in the environmental context and in the development of the local territory. So, I can get some conclusions on the new perspective for the food system, promoting social and environmental development. Thinking about a food territorial system means the guidance of politic, scientific, organisational, designing processes, based on the generation of increased relationships, shared visions and strategies (cross, pervasive, and fundamental ones).

From the results of the analysis and experience showed in these paper, the main important aspects for a sustainable food sector are:
\ generation of food local networks;
\ shared responsabilities among the different keystone players;
\ increased relationships with the context;
\ conscious behaviours of all players.
At the end the new food system can/should promote social and environmental development (figure 2).

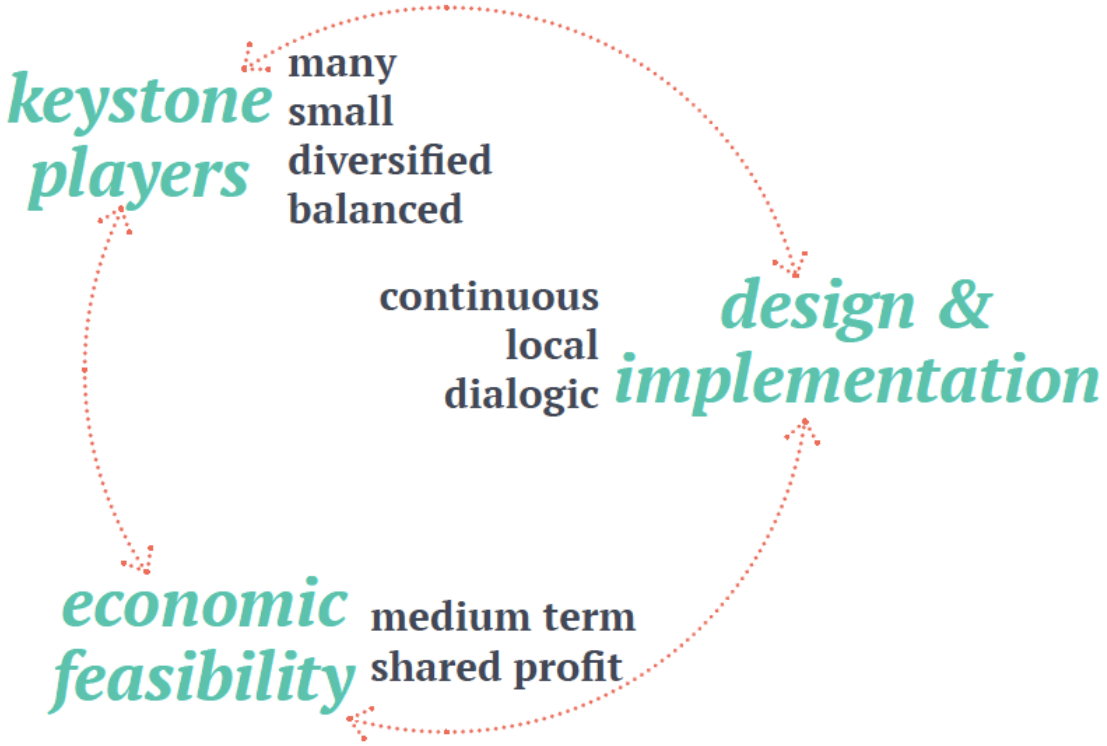

figure 2: main characteristics for the future sustainable food strategies.

References

Bistagnino, L. (2009). *Systemic Design: Designing the productive and environmental sustainability*. Bra, Italy: Slow Food.

Buchanan, R. (1992). Wicked problems in design thinking. *Design Issues, 8* (2), 5-21.

Capra, F. (1997). *The Web of Life: a New Synthesis of Mind and Matter*. London, England: Flamingo.

Chertow, M.R. (2000). Industrial Symbiosis: Literature and Taxonomy. *Annual Review of Energy and Environment, 25,* 313-337.

Chertow, M. R., Ashton, W., & Kuppali, R. (2004). *The Industrial Symbiosis Research Symposium at Yale: Advancing the Study of Industry and Environment*. New Haven, CT: Yale School of Forestry & Environmental Studies.

Collins, D.A. (2010). Heading for a World Apocalypse? *The Journal of Social, Political, and Economic Studies, 35 (2),* 296-302.

Fiksel, J. (2003). Design Resilient, Sustainable Systems. *Environmental Science & Technology, 37 (33)*, 5330-5339.

Frosh, R.A., & Gallopoulos, N.E. (1989). Strategies for Manufacturing. *Scientific American, 3 (189),* 94-102.

Fuller, R.B. (1981). *Critical path*. Ney York City, NY: St. Martin's Press.

Gustavsson, J., Cederberg C., & Sonesson U. (2011). *Global Food Losses and food waste. Extent causes and prevention.* Rome, Italy: FAO.

Jones, P.H. (2009). Learning the lessons of systems thinking: Exploring the gap between Thinking and Leadership. *Integral Leadership Review, IX* (4).

Lovelock, J. E. (1988). *The Ages of Gaia: a Biography of our Living Earth*. New York, NY: Norton.

Maturana, H. R., & Varela, F.J. (1972). *De Maquinas y Seres Vivos. Una teoria sobra la organizacion biologica.* Santiago de Chile, Chile: Editorial Universitaria.

Mcculloch, W.S., & Pitts, W.H. (1948). A Logical Calculus Of The Ideas Immanent In Nervous Activity. *Bulletin Of Mathematical Biophisics, 5,* 115-133.

Pisek, P.E., & Wilson, T. (2001). Complexity, Leadership, and Management in Healthcare Organizations. *British Medical Journal, 323,* 746-749.

Porter, M.E. (1990). *Competitive Advantage of Nations.* New York City, NY: Free Press.

Schrödinger, E. (1946). *What is Life? The physical aspects of living cells*. Cambridge, UK: Cambridge University Press - The Macmillan Company.

Senge R. E. (1993). *The Art of Case Study Research,* Thousand Oaks, CA: Sage Pubblication.

Shannon, C.E. (1948). A Mathematical Theory Of Communication. *Bell System Thecnical Journal, 27 (623-656),* 379-423.

Shiva, V., (1993). *Monocultures of the Mind. Perspectives on Biodiversity and Biotechnology*. London, UK: Zed Books Ltd.

Von Bertalanffy, L. (1968). *General System theory: Foundations, Development, Applications.* New York City, NY: George Braziller.

Wiener, N. (1948). Cybernetics: or Control and Communication in the Animal and the Machine. Paris, France: Hermann & Cie.