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*Original*

Systemic Design for Sustainable Healthcare / Barbero, S., Pallaro, A.. - ELETTRONICO. - (2017), pp. S2473-S2485.  
(Design for Next | 12th EAD Conference Sapienza University of Rome 12-14 April 2017)  
[10.1080/14606925.2017.1352762].

*Availability:*

This version is available at: 11583/2701439 since: 2018-02-26T10:21:34Z

*Publisher:*

Taylor and Francis

*Published*

DOI:10.1080/14606925.2017.1352762

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Taylor and Francis postprint/Author's Accepted Manuscript

(Article begins on next page)



# The Design Journal

An International Journal for All Aspects of Design

ISSN: 1460-6925 (Print) 1756-3062 (Online) Journal homepage: <http://www.tandfonline.com/loi/rfdj20>

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To cite this article: Silvia Barbero & Agnese Pallaro (2017) Systemic Design for Sustainable Healthcare, The Design Journal, 20:sup1, S2473-S2485, DOI: [10.1080/14606925.2017.1352762](https://doi.org/10.1080/14606925.2017.1352762)

To link to this article: <https://doi.org/10.1080/14606925.2017.1352762>



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Published online: 06 Sep 2017.



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# Systemic Design for Sustainable Healthcare

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**Abstract:** The healthcare sector is a complex system that is facing new emerging trends without, however, having the proper resources and structures to address them. The necessity for a change in the approach to new challenges of the healthcare sector provides a stimulating field of application for design disciplines. One of the major issues to be tackled is the transition of the sector towards a more sustainable development, in which designers play a crucial role. The paper presents the approach and the methodology applied by the Systemic Innovation Design Network research team of the Department of Architecture and Design at Politecnico di Torino and discusses the potentialities offered by the application of a Systemic Design approach to healthcare, as an effective way of addressing the complexity of the issue.

**Keywords:** healthcare, systemic design, sustainability, sustainable healthcare

## 1. Introduction

The healthcare sector is experiencing dramatic changes that pose new challenges to the current model, influencing it at different levels, especially in developed countries.

The pathologies are changing: the aging population and the increase of long term conditions are posing unprecedented challenges to the healthcare system requiring a shift from the cure of acute conditions to prevention (Chamberlain et al., 2015). The diffusion and improvements in technology opened new modes of access to healthcare treatments in the so called Health 2.0 (Jones, 2013) redefining the places of healthcare provision -not anymore confined to hospitals or healthcare centers, but relocated in patients' homes- and changing the very role of patients that are not anymore only passive users of the treatment but become active protagonists of the cure. These emerging trends must face the increasing lack of resources due to the long lasting effects the economic downturn still has on the healthcare sector that led to reduction of expenditures and cutbacks (UPS, 2014). Nevertheless, the economic crisis has also acted as a promoter of environmental sustainability, which is becoming a business strategy for healthcare: an increasing number of healthcare centers is considering sustainability in their set of selection criteria for suppliers and is implementing measures to reduce waste produced, recognizing that these measures correspond to savings in expenditures (Johnson & Johnson Services, 2012).

These trends identify healthcare as a system affected by increasing complexity caused by “a set of problems with inextricable interdependencies” (Jones, 2013 p.XV) that refer to illnesses themselves and to the healthcare system as a whole, made of interactions among patients, medical personnel, workplaces, tools, services, environment, society, policy framework and so on. An additional source of complexity is the lack of agreement among actors of the healthcare sector about the meaning of the common goal “to keep people healthy”: as Kanter (2011, second paragraph) points out “lack of consensus among players in a complex system is one of the biggest barriers to innovation. One subgroup’s innovation is another subgroup’s loss of control”. Moreover, the boundaries of healthcare system are continuously changing and expanding, because of the aforementioned trends. Patients gain new knowledge, tools, awareness and competences thus slightly changing their role; healthcare staff acquires new tools to access, store and exchange information modifying the way of interaction with patients; new variables –such as environmental impacts of treatments- have to be taken into account; the type and duration of illnesses change requiring the system to adapt to it.

The contrast between the complexity of these challenges and the established linear model according to which healthcare organizations are set emerges clearly from literature analysis (Roberts et al. (2016). As Burns et al. (2006, p.8) underline “Traditionally, organizations have been designed for a complicated rather than a complex world”: while the linear approach enables to analyze effectively problems by breaking them into sub-issues, it is not sufficient to understand the complexity of interactions of new problems as a whole. These new challenges require a radically different approach to problems that constitutes a potential field of application for design disciplines.

The paper presents the approach and methodologies applied by the Systemic Innovation Design Network (SIDN) research team discussing the potentialities offered by the application of a Systemic Design approach to healthcare, as a method to address properly the complexity of the issue.

## 2. Design for Healthcare

The application of Design Thinking approach to complex problems of the healthcare sector can bring several benefits that are nowadays increasingly recognized.

Roberts et al. (2016, p.11) argue that design thinking can offer

“a well-defined and recognizable practice framework for the broad-scaled integration of more creative, interdisciplinary and human-centered approaches to healthcare management, innovation and practice”.

Three main elements of design thinking can bring value to healthcare: (i) empathy, referring to the analysis of expressed and latent needs of users to understand them and design appropriate solutions; (ii) multidisciplinary collaboration with different stakeholders; and (iii) rapid prototyping to test several rough ideas and select the best ones (Roberts et al., 2016). Empathy is the feature that marks the greatest difference between design thinking and other traditional approaches to healthcare: the focus is first on the users –mainly patients and caregivers- around whom the system is then designed (Faste, R.A., 1994). The cause of the majority of problems at the core of the healthcare sector (i.e. the moment when treatments are provided) can indeed be traced in the wrong design of the system, which was conceived assuming that people would adapt to it, instead of the other way around.

Design thinking can thus provide a methodology, a toolkit made of guidelines to identify the right problems and properly address them (Jones, 2013).

The opportunities for the successful application of design thinking approach to healthcare are manifold: from re-design of tools and environments, to services and flows of information between healthcare staff and patients (D'Avolio, 2015), to the re-definition of the experience of the treatment itself (Nichol, 2010). The results of the thorough analysis conducted by The State of the Art of Design in Health (Chamberlain et al., 2015) highlight as the major outputs (in terms of quantity) of design intervention in healthcare in the UK the production of Digital Artifacts and Physical Products. The former ones are related mainly to Health Informatics, Tele-health/care/med, mobile applications and websites demonstrating the multiple opportunities digital technologies offer to healthcare sector. The latter ones, instead, is led by Assistive Technology, such as the wearable devices, followed by Medical Products (Chamberlain et al., 2015).

Although the number of potential action points for designers in the healthcare sector is vast, design is still not fully integrated into healthcare organizations and there is no clear understanding of designers' role (Jones, 2013). Freire and Sangiorgi (2010) propose an interesting analysis of the evolution of healthcare sector in UK as parallel to the change in economic paradigm, highlighting the repercussions for the role of designers. At the beginning, healthcare service was structured according to a Fordist model: knowledge was the property of few experts, patients were users and the focus was on the efficiency of the service. The shift from mass-production to mass-customization occurring in the industrial world was mirrored in the healthcare sector, where more attention was dedicated to patients' needs to provide personalized services. More recently, the further change from mass-customization to mass-collaboration and open innovation led to the establishment of a participatory model of healthcare, where patients are involved increasingly as co-creators. The role of designers changed in the process from creators of products and services in the linear paradigm to facilitators of connections between different stakeholders involved and providers of tools and methodologies to assess properly the complexity of current healthcare issues (Freire and Sangiorgi, 2010). This complexity originates partly because in the healthcare sector each case (each patient) is almost unique and different from the others, which makes hard to serialize a solution. The role of designer has also acquired new features in the last decades as a consequence of the increasingly recognized evidence of the necessity to encourage a more sustainable development. The path to reach this goal requires changes in the whole economic model influencing several players at different levels. Designers, as actors in relation to both consumption and production, have a crucial role in supporting the transition towards sustainability, promoting the environmental quality of products and services and making new sustainable ways of living feasible (Vezzoli, 2003).

The trend towards sustainability in the healthcare sector has already been mentioned; in the next section the meaning of the term *sustainable healthcare* is discussed.

### 3. Design for Sustainable Healthcare

The path towards sustainable development led to the widely shared definition provided by the UN in the Brundtland Report (1987):

“Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs”  
(UN, 1987)

Three dimensions are considered in sustainable development: economic, environmental and social sustainability. Since the aim of medicine is to ensure the health of people, this has, of course, been always more important than ensuring the health of the planet. However, in developed countries, where a high level of healthcare has been reached, growing attention is being devoted to the issue of

environmental sustainability in close relation to the economic one. Nevertheless, even though sustainability is increasingly arising interest in healthcare, there is no clear and shared definition of Sustainable Healthcare (SH).

The term SH should be distinguished from Sustainable Health and Environmental Health, even though it can involve both. Sustainable Health deals with disease prevention and promotion of healthy lifestyles; Environmental Health concerns the effects of the environment on health (Eriksson et al., 2015); SH, according to Eriksson et al. (2015), addresses the sustainability of healthcare structures, behaviors and technologies.

The concept of Sustainable Healthcare evolved overtime. If at first it was linked closely to economic aspects, further attempts to define it considered the importance to balance patients and workers needs, economic and environmental costs, social and cultural dimensions to create a system that works in harmony with people and the environment, preserving resources for future generations (Fischer, 2015). Despite these definitions, so far the concept of sustainability in healthcare has been related mainly to financial issues whereas little attention has been paid to other social and environmental dimensions (Marimuthu and Paulose, 2016).

The pursuit of SH is influenced by several variables that span across different levels, from the institutional and economic management to the involvement and awareness of healthcare workers. The main key elements emerged from literature review include: long-term planning and capacity of adaptation of the healthcare system; the necessity to develop policies to promote SH; the organizational commitment of healthcare workers and their training on sustainability improvement at workplace; the importance to involve all stakeholders interested in the issue; the empowerment of patients to enable them to be responsible of their own health (Fischer, 2015; Ryan-Fogarty et al., 2016; Yih Goh and Marimuthu, 2016; Grose et al. 2012; De Francisco Shapovalova et al., 2015).

Since healthcare is a complex system, the concept of SH should consider the many different variables of economy, environment and society to reflect this complexity. The trends emerged from literature review highlight the importance of applying a holistic approach to sustainability in the healthcare sector; however, this point is addressed rarely and sustainability is currently related mainly to management and environmental aspects (Marimuthu and Paulose, 2016). A holistic vision of SH should not consider only the social, economic and environmental impacts of the treatment. It should also take into consideration the care seekers and care providers in relation to their context by analyzing the interactions they establish among them and with the context itself, assessing the influences from and consequences they generate on it. This is the core of the Systemic Design approach, whose principles are discussed in the ensuing paragraph.

## 4. Systemic Design for Sustainable Healthcare

The term *systemic design* is often used with different meanings; this paper refers to the Systemic Design (SD) approach developed by professor Bistagnino (2011).

SD approach is rooted in the system thinking developed from the beginning of twentieth century through various methodologies based on the aim to consider problems as systems and analyze them in their complexity starting from the interactions among their components (Sposito and Faggian, 2013).

SD approach focuses on the enhancement of material and energy output of production processes as input for other ones, which is one of the keys for sustainable development. Taking inspiration from Nature, the waste of a process are studied in order to make them resources for another one. The

effects of this action on environmental sustainability interest different levels. The reduction of waste and its enhancement as a resource leads to the reduction of the environmental impact of processes, tending to zero emissions, enables the creation of new products and services, generates a new economy and distributed wealth for the society (Bistagnino, 2011). The application of this principle to the waste of the healthcare sector could have a particularly considerable impact, as it could lead to a reduction of management costs and to the redesign of the entire system. Beside the output-input connection, SD approach is built around four additional key principles that contribute to environmental, social and economic sustainability: the (i) *relations* existing among components generate the system itself enabling its (ii) *autopoiesis* and increasing its resilience through a higher economic and social robustness; (iii) *to act locally*, the local context in which the system is located is prioritized, leading to a reduction of long-distance transports and decreasing emissions; (iv) *human-centered design*, in relation to its environmental, social, cultural and ethic context.

The methodology applied by SD follows six main steps:

**Holistic Diagnosis;** this step refers to the gathering of quantitative and qualitative data concerning the social, cultural, economic, productive and environmental context through desk and field research. The data collection phase is followed by the analysis of the interactions among them. To enable a better and easier interpretation of these data, graphics is used as a valuable tool to visually illustrate findings.

**Definition of problems and leverages for change;** the analysis carried through the holistic diagnosis enables problems to be highlighted. The system perspective enables to detect not only problems related to a specific element, but also the ones generated by the interaction of different components. Problems are seen as opportunities to work on for the development of the project.

**Design of a system;** once the issues have been addressed properly, a solution is designed. New inputs, generated by the transformation of the outputs previously considered waste, are defined.

**Theoretical studies of the outcomes of implementation;** before implementing it, the effects that the projects could generate are studied to foresee criticalities. The system perspective is maintained in this step: the consequences of the project are studied at both the components and system level from the environmental, economic and social point of view.

**Implementation;** the system designed is built going through a transitory stage where changes to the current model are made and new connections are created.

**Analysis of results and feedbacks;** the methodology follows an iterative journey with continuous feedback cycles to enable the system to adapt to changes that can occur.

(Barbero S., 2016)

The SD approach is one of the pillars applied by the Systemic Innovation Design Network research team, born in 2015, giving a common identity to a group of designers experts in different disciplines, such as systemic design, interaction design, communication design and information design. The topics investigated by the team vary from the agrifood sector to the study of interfaces, bearing sustainability and its communication in mind in order to create systems that balance social, environmental and economic aspects.

A new research path on design for healthcare has been developed in recent years by the team, focusing mainly on the sustainability of health treatments and on the improvements of the interaction between doctor, patient and cure. The topic is addressed from different perspectives, creating four design branches that are currently being explored: product design, communication

design, e-health/m-health and systemic design. A brief description of case studies of projects is provided aiming at presenting the features that these projects share with Systemic Design, highlighting the fact that these characteristics are related strongly to their sustainability.

- Communication Design

**Degust'Alp** (2013-2014). Scientific supervisor: Paolo Tamborrini. Team: Gabriele Fumero. In cooperation with: Regione Piemonte, Provincia di Torino, Camera di Commercio di Torino.

Degust'Alp project consists in a communication campaign for the canteen of Politecnico di Torino to increase the awareness of users about local food products, promoting their consumption and emphasizing the relation between food, health and environment. The communication uses illustrations and short ironic texts to attract attention and convey an important message in a way easy to understand and to remember.

SD guidelines: act locally.

Far from being a mere marketing campaign, the project focuses on the promotion of local food as a promoter of healthy life style: the aim of Degust'Alp goes beyond the canteen to educate people towards a healthy and balanced diet. The emphasis on local consumption supports not only the environmental and social sustainability of the project, but promotes also the development of a local economy intended to preserve the territory.

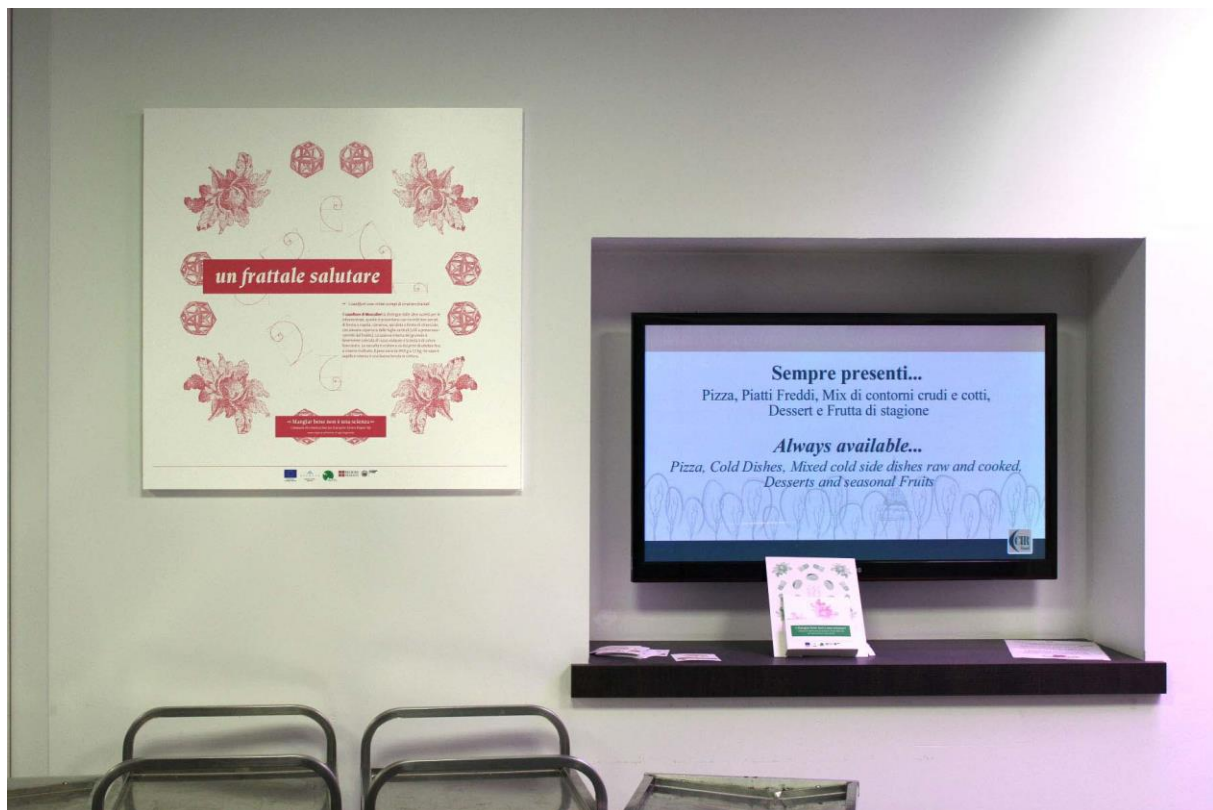


Figure 1. Degust'Alp project. Courtesy of the authors.

- Product Design

**NUF - Portable filter** (2016). Scientific supervisor: Paolo Tamborrini, Fabrizio Valpreda. Team: Mauro Sorrentino, Eleonora Fiore, Amina Pereno, Maurizio Rosso. In cooperation with: NUF Filtration.

NUF is a product for the depuration of water in Sub-Saharan Africa through the reuse of filters for the dialysis treatment. A thorough analysis of the cultural and behavioural scenario of the involved countries was carried out to design a product that would be functional, easy to carry and culturally accepted by the users. The product has been designed and it is now in the prototyping phase.

SD guidelines: output-input, act locally, human-centered design.

The reuse of the filter (output) as a tool to purify water (input) is the core of the project developed to answer to human's basic needs and around them and in close relation to the local context it is shaped in order to ensure its social acceptance.



Figure 2. Extracts from the research phase. Courtesy of the authors.

- E-Health and m-health

**Digital tools for diabetic children** (2014). Scientific supervisor: Paolo Tamborrini, Andrea Di Salvo. Team: Elena Bragardo. In cooperation with: Reparto di diabetologia dell'Ospedale di Chieri (Turin).

Diabetes is an increasingly common disease which requires careful management by the patient that is, however, harder to reach in the case of children. The app developed is connected to an ad hoc tool for the measurement of blood glucose and provides suggestions and guidelines for a healthy diet, based on the measure performed and the seasonal availability of food.

SD guidelines: act locally, human-centered design.

The guideline "act locally" promotes a healthy life style that in this case means eating seasonal food: the project educates the user towards a wholesome diet beyond the app, stimulating sustainable behaviours. Seasonal food locally available indeed implies a lower use of resources to produce and transport it. The centeredness of the user emerges also from the tool chosen to develop the project: the choice of the Smartphone is in line with the requirements of the monitoring of diabetes, the needs of the users and their behavioural habits.



Figure 3. The app that developed for diabetic children. Courtesy of the authors.

- Systemic Design

**Cuochi d'argento** (2015). Scientific supervisor: Paolo Tamborrini, Luca Davico. Team: Mauro Sorrentino.

Elderly have specific dietary needs, which are usually unknown to them. The project aims to provide elderly a guide for a balanced and healthy diet actively involving them in the project as promoters of local food and healthy lifestyles.

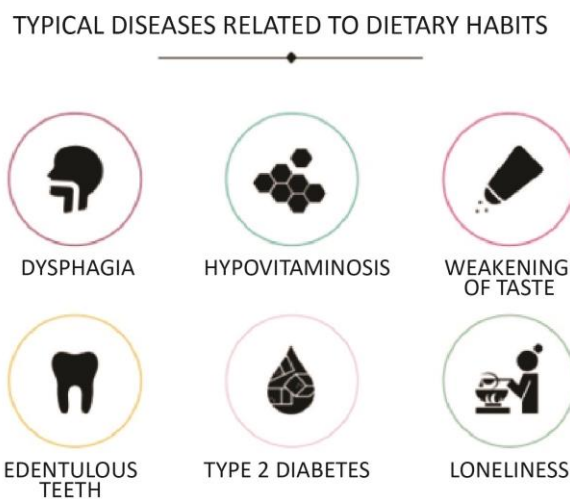


Figure 4. Typical diseases affecting the elderly. Courtesy of the author.

SD guidelines: act locally, human-centered design, relations, autopoiesis.

Cuochi d'Argento is shaped on the features and needs of the users and around them builds a network of relations that becomes the structure of the system, enabling it to self-generate and expand. In this case, "act locally" does not only mean to eat local food, but –more importantly- to build relations at the local level. The project promotes behaviours that are sustainable at the

environmental, social and economic levels (by decreasing the occurrence of pathologies, the costs for treatments are reduced).

**Recovery of hospital food waste** (2014 – 2017). Scientific supervisor: Silvia Barbero. Team: Debora Pilati, Serena Zerbinati, Daniela Ballardini, Paolo Mussano. In cooperation with: Ospedale Maria Vittoria (Turin).

Food waste is usually a large part of the waste produced by hospital wards. The project enhanced the value of food waste through two types of actions: the prevention of waste generation by educating and engaging health workers and users; and reuse of edible and inedible waste through the involvement of association on the territory.

SD guidelines: output-input, act locally, relations.

The project addresses one of the most problematic issues in hospitals from the point of view of waste of resources by making the output of a process input for many others, acting locally to create a network of relations on the territory that enables the soundness of the system. The type of sustainability promoted is economic (reduction of the cost of waste disposal), environmental (reduction of environmental impacts related to the disposal) and social (enhancement of a resource donated to those in need).



Figure 5. Extracts from the research phase: steps of food preparation and disposal. Courtesy of the author

**Eco-dialysis** (2014 – 2017). Scientific supervisor: Paolo Tmborrini, Silvia Barbero. Team: Amina Pereno. In cooperation with: SS Nefrologia at Ospedale Universitario San Luigi Gonzaga (Turin).

The research addresses the topic of environmental sustainability of the chronic dialysis treatment, which is very expensive in terms of consumed resources and waste produced. The project combines short-term objectives, related to the sustainability of packaging and medical products, and long-term objectives, designing a complex and sustainable system of dialysis treatment, including the equipment.

SD guidelines: human-centered design, relations.

The project provides a different contextualization of the guideline “build relations” by investigating the relations existing between the packaging, the machine for dialysis, the operator and the user, to optimize them and create an effective system around the needs of the patient. At another level, the

relations between the different components of the dialysis machine are explored in order to optimize the fluxes of matter and energy within it.

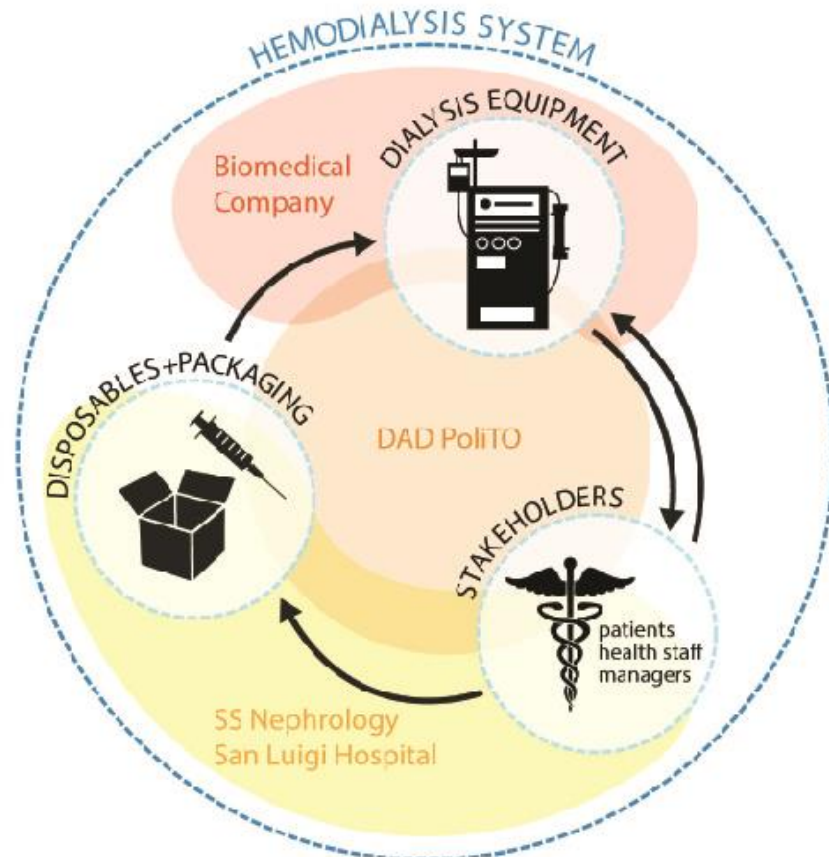


Figure 6. Analysis on the packaging for dialysis. Courtesy of the authors.

## 5. Discussion

The case studies analyzed present the state of the art of the research developed by the Systemic Innovation Design Network team in the field of healthcare. The comparison between the projects developed through different methodologies highlighted that, the higher the complexity of the project, the higher the number of elements in common with Systemic Design methodology. For example, the design of a filter from the reuse of an element at the end of its life, developed in a very specific cultural and social context such as the African one presents a greater level of complexity than the creation of a communication campaign to raise awareness on the consumption of local food.

This relation between the complexity of the project and the number of elements in common with Systemic Design appears to be coherent with the hypothesis that SD provides a particularly proper methodology to address the complexity of the healthcare sector, considering it an added value rather than a problem to be reduced to single issues. The solutions provided are complex as well, but not complicated, to best suit the context for which they are designed. Future works will investigate another contribution that SD can offer to healthcare, the application of the output-input principle to the enhancement of special waste (currently disposed with high treatment costs) through upstream and downstream interventions.

## 6. Conclusion

The healthcare sector is facing emerging trends that it is unprepared to address. The complexity of the healthcare sector is increasing: the actors assume new roles and the borders of the system are expanding through new technologies, tools, flows of information and relocation of the cure. These new challenges require a radically new way to address problems. The benefits brought by the application of design thinking to these complex issues to develop effective solutions and the crucial role designers have in the transition towards sustainable development have been discussed. The paper focused on one of the major challenges faced by healthcare sector, the transition towards environmental sustainability, presenting the methodology of SD as a suitable tool to address it. A collection of case studies of projects developed by the Systemic Innovation Design Network research team has been presented. The comparison between the features of the projects and the principles of Systemic Design highlights the correlation between the degree of complexity of projects and the number of characteristics they share with the guidelines of SD. This finding appears to support the hypothesis that SD provides a methodology to address properly the complexity of the problems related to healthcare.

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**Acknowledgements:** Many thanks to Professor Luigi Bistagnino, author and promoter of the Systemic Design approach for his help in the development of the topic.