Indian Journal of Fundamental and Applied Life Sciences ISSN: 2231– 6345 (Online)
An Open Access, Online International Journal Available at www.cibtech.org/sp.ed/jls/2015/01/jls.htm
2015 Vol.5 (S1), pp. 1251-1261/Anzabi
Research Article

AN INVESTIGATION INTO THE IMPACTS OF SUSTAINABLE DEVELOPMENT ON SHIFTING PRODUCT DESIGN PARADIGMS

***Naimeh Anzabi**
Department of Industrial Design, Faculty of Applied Arts, Tabriz Branch,
Islamic Art University, Tabriz, Iran
**Author for Correspondence*

ABSTRACT
Sustainability has been broadly discussed in recent decades in international societies. The increased destruction of environment and wasteful use of natural resources, together with increased consumption of material goods and complexity of lifestyles, have resulted in the emergence of the so called sustainable development model which tries to make a balance between environment, economy and society. Considerable changes in various fields of production, industry, economy, lifestyle and consumption have been occurred due to sustainability theories. To this end, the field of product design has changed too, in order to achieve the goals of sustainable development. It is because the design, as an intrinsic part of industrial production with a direct role in the quality of production and consumption, is considered as a main driver for environmental impacts of products. This paper aims at identifying the changes which appeared in the design discipline due to the entrance of sustainability theories with a descriptive-analytic manner. It is found out finally that, the radical change in design process is shifting from product orientation to services. So the design methods and innovation patterns should be changed too, in order to achieve the new consumption and production pattern with the axial role of services. The level of design innovation brought to this process turned from individual innovation into social and systematic innovation. Along with, the design paradigm transformed from a linear process to network of actors that all related actors cooperate with each other. These exchanges extended the definition and tasks of designers and introduced new fields to their scope.

Keywords*: Sustainability, Sustainable Development, Product Design, Innovation, Service*

INTRODUCTION
Sustainability nowadays, is a widely used concept in different fields. Since 1980s, which human impacts on earth have been studied more seriously, the sustainability concept defined more comprehensively. Sustainability is now broadly recognized as a comprehensive concept that implies a desire for greater equity, quality of life and environmental well-being for today and future generations (Pine and Gilmore, 1999). It is, in fact, a scheme that improves and develops humane lives.

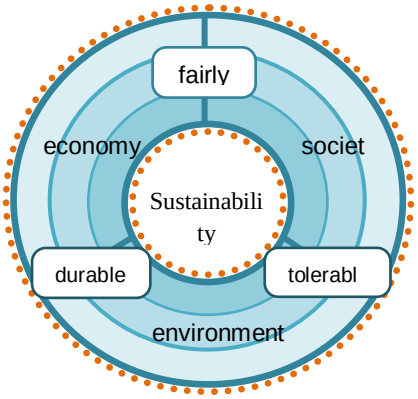

Figure 1: Sustainability admits three major dimensions. Sustainable development has been studied in three sections: environmental sustainability, social sustainability and economic sustainability aimed at intersecting and interacting of these three fields

Sustainable development, which was globally accepted following the final report of the World Commission on Environment and Development in the middle of 1987, is defined as a development that takes into account current needs looking at the rights and capabilities of future generation in dealing with their needs. It is divided into three major sections: a) environmental sustainability, b) economic sustainability and c) social sustainability (Figure 1).

This classification reveals that sustainable development not only concentrates on environmental factors but also creates an infrastructure where society, environment and economy interact with each other in a balanced way. This means that the models and designs are accepted in sustainable development pattern which concerns not only environmental factors but also social and economical issues as well. Therefore, sustainable development approach challenges all fields from policy and economy to commerce, companies, manufacturers, people, culture, design, market and so on (Brezet, 1997). Thus, it can be argued that as sustainability became more important, design paradigms were changed. Some other approaches like eco-design and green-design have been evolved as a result of paying more attention to environmental factors in the process of designing industrial products. However, achieving the ultimate targets of sustainable development demanded deeper and more fundamental changes in design discipline. Therefore, the requirements of sustainable development made some changes in the definition of product, design and production. This article emphasizes to clarify these changes.

Concentrating on the importance of sustainability, different authors have studied this subject and stated different opinions about the relationship between design and sustainable development and their mutual interactions. This topic has been studied for more than 15 years and reputable authors like Stahl, Goed Koop, Mount, Brezt, morelli and Vezzoli were the most studious scholars. Most of the scholars considered the design as a tool for promoting sustainability and tried to find solutions to develop design targets to access sustainable development. In their book titled as "design for environmental sustainability", Vezzoli and Manzini (2008) introduced methods and approaches for a design conforming to environmental considerations (Weber and Steinbach, 2004). Morelli studied this subject in Alborg University and published many articles and books about the impacts of industrial products design on the increase of destructive effects on environment. He also investigated the new approach that should be followed by design discipline.

This study tries to identify the impacts of sustainability and sustainable development on products itself, product design, innovative and creative systems, production and industry logic and role of designers. According to studies, it seems that as sustainable development becomes more important, attentions turn from industrial products into services and the change of preferences causes the change of design and innovation structures.

MATERIALS AND METHODS

Methodology

This is a descriptive-analytic study. A descriptive study describes and interprets current conditions and relationships and evaluates current status of a subject or phenomenon. Regarding the nature of our study's subject, related data was collected through related literatures, articles, thesis or other related resources. The resources were selected from books available and accessible in Iran and Internet.

Emergence of Services: (From Finished Products to Service Oriented Systems)

Looking back on the history of the western industrial model and society, the 1950s to the 1970s can be seen as essentially manufacturing and product-driven years and the population concern primarily to own and possess physical assets to create identity and status (Vezzoli and Manzini, 2008). The prevalence of such a consumption culture, which was an outcome of the age of industry, mass production and wide presence of products in markets, resulted gradually in different environmental problems like, global warm, heap of garbage and excessive use of natural resources in recent years. This made international societies to become more sensitive to environment because the more consumption results in more production and finally pollution occurs in production and consumption phases, which leads to the entrance of a huge volume of waste materials to the nature. Although current products are

environmentally more advantageous than previous ones (for example, modern cars emit low pollution compared with 1970s cars) but this advantage is neutralized by the increased consumption rate (Brezet, 1997). Therefore, a change in production and consumption patterns was necessary in order to make them more compatible with environment. That is because observing environmental factors cannot be satisfied only by changing production processes and it demands the change of consumption patterns as well. To this end, the modification of consumption culture, which is more destructive than environmental pollutants in many aspects, became more important. Therefore, instead of making small changes, it was necessary to introduce a new different approach for offering products to consumers, in order to make significant changes in the environmental aspects of products. In other words, it was necessary to change attentions from tangible products to a systemic solution including services and products (Vezzoli, 2006) in which the relationship between the designer and the consumer is reconsidered to provide companies with environmental and economic benefits. Thus, in future decades companies will have no choice to reduce production and consumption of physical products in order to compete with each other. Although this is a consequence of environmental targets, it makes serious socio-cultural and economic challenges too. Aware that the path towards a more sustainable society requires a de-materialization of our production and consumption system (Wilt, 1997), new solutions can be researched within an emerging knowledge and service economy. The improved use of products as well as selling the results of a physical product to customers, instead of the product itself, was a way for decreasing consumption level (Manzini, 1997). Indeed, in many cases what customers really need today is not a physical product but rather the result that a tangible asset provides an answer to a specific demand. In other words, what we are seeing is a growing realization that people do not value physical goods or ownership of them for their own sake. On the contrary, the goods seem merely a means to an end to satisfy a customer's needs (Wilt, 1997). Therefore, the companies with production-oriented activities tried to find new combined systems creating added value through non-physical parameters like services. From environment point of view, selling services instead of physical products can change customers' concentration on tangible products. This can be considered a way for eliminating materialistic-physical industrial products which, in turn, can reduce environmental impacts. Moreover, this combined system of products and services can assist to create environment friendly sustainable products (Manzini, 1997). This is why the companies with production-oriented activities were looking for new systems. According to Rifkin (2000) "*revolutionizing in product design happens to reflect the new emphasis on services. Instead of thinking of products as fixed items with set features and a one-time sales value, companies now think of them as 'platforms' for all sorts of upgrades and value-added services*".

Among different factors associated with sustainability, environmental factors are likely the most influential factors forcing companies to approach towards modern service strategies. Production companies are obliged to develop international environment rules, which are beyond typical considerations applied to production and waste materials during production process, in order to use the rules in some processes like product design and product destroy after its expiration (Wilt, 1997). Today, theses legal forces have caused some companies to look for new strategies in order to reuse and recover their products. Some companies like Xerox and Packard lie inside this category (Wilt, 1997; Rifkin, 2000).

The companies have promoted the environmental performance of their products by designing for environment, product reuse and developing related services, by which they not only have achieved customer satisfaction but also have achieved economic profit (Wilt, 1997).

Considering the targets and definitions of sustainable development, it can be argued, therefore, that there are different ways for achieving sustainable development. In all methods, consumption pattern should be taken into account in addition to industrial production processes. Environmental impacts are the consequences of production, consumption, economic development models and culture and economy factors. Therefore, achieving sustainability demands fundamental changes in production, consumption, trading, industry and economy. Such a need resulted in the emergence of service-oriented approaches which offer solutions to customers and satisfy their needs instead of offering physical products. Meeting

customers' needs by a new combined package named products service systems was an approach appeared due to this need and caused different challenges to industry, trade and design.

Change in Innovation Models

As it was mentioned in previous section, concentration on sustainable development resulted in the emergence of a new wave of providing services following production-orientation age where the concentration of production and design processes changed from manufacturing industrial products to services. Such an approach challenged all design and production fields. It required a new method because the nature of services differs from that of industrial products and they have not the same requirements. As the fundamental basis of design, innovation was consequently changed. It can be argued that, when design models are changed due to concentration on services, innovation and creativity models are changed in advance.

A change towards sustainability, demands fundamental changes in production and consumption methods or, life style. This framework clarifies the link between the environmental and social dimensions of a problem and reveals that there is a need for a radical social innovation in order to move from current non-sustainable consumption models to more sustainable models. According to the dimensions of this change, moving towards sustainability resembles a social learning process in a large scale that requires a systematic evolution. Therefore, a systematic approach which is followed to achieve sustainability becomes very important and it can be named as systematic innovation.

If the design area wishes to shift towards sustainable design it should pay a particular attention to the systemic innovation (i.e. the shift of strategic-oriented design towards the development of local and network innovation). Design for systemic innovation with the purpose of obtaining sustainability initializes with local innovative approaches. On the other hand, it develops inter-cultural creativity in order not to restrict itself in this level and to have a share in moving towards sustainability along with social creativity (Goedkoop *et al.*, 1999).

The new approach to innovation has been described by Brezet (1997) as follows:

Type 1: Product improvement. This involves only partial changes and improvements to various aspects of a product and the product itself and the production techniques stay the same. Examples of this include changes in the type of coolant or substances used in a television set to improve its environmental performance in comparison to a predecessor model.

Type 2: Product redesign. In this case, the typology of the existing product remains unchanged. However, its components are improved or replaced in order to facilitate disassembly, recycling, re-use procedures or energy use reduction. Examples include energy saving systems in a television set, and the introduction of recyclable plastic parts or modular easy-to-replace components.

Type 3: Function innovation. This type of change is no longer confined to the existing product concept. Here, the way in which the function is fulfilled is different. The old television tube, for example, is replaced with other image carriers (LCD monitor instead of CRT-based monitor, or replacement of the television with a light projector). Through these innovations, environmental performance in fulfilling the function can be improved by as much as a factor of 10.

Type 4: System innovation. Here, the entire socio-technical system (the product, the production chain, associated infrastructures and institutions) is replaced by a new system. One example of this is the use of information and communication technology to deliver information and images to the end-users through video-on-demand systems (Maussang *et al.*, 2006) (Figure 2).

If type 1 and 2 of such innovations are still related to an eco-design paradigm by their proposal of incremental environmental product improvements, type 3 and 4 carry out the kind of radical changes required by a sustainable design or design-for-sustainability paradigm. They bring into the design process the discontinuity necessary to create solutions designed to rely on only 10% of the resources used in solutions currently available. The value of these paths, as well as their limits, can be summarized with a few observations. On the one hand, they open a new mindset and design perspective in which designers (tend to) become actors who act within a more complex network of stakeholders, and take on the role of facilitators in a participatory value creation process.

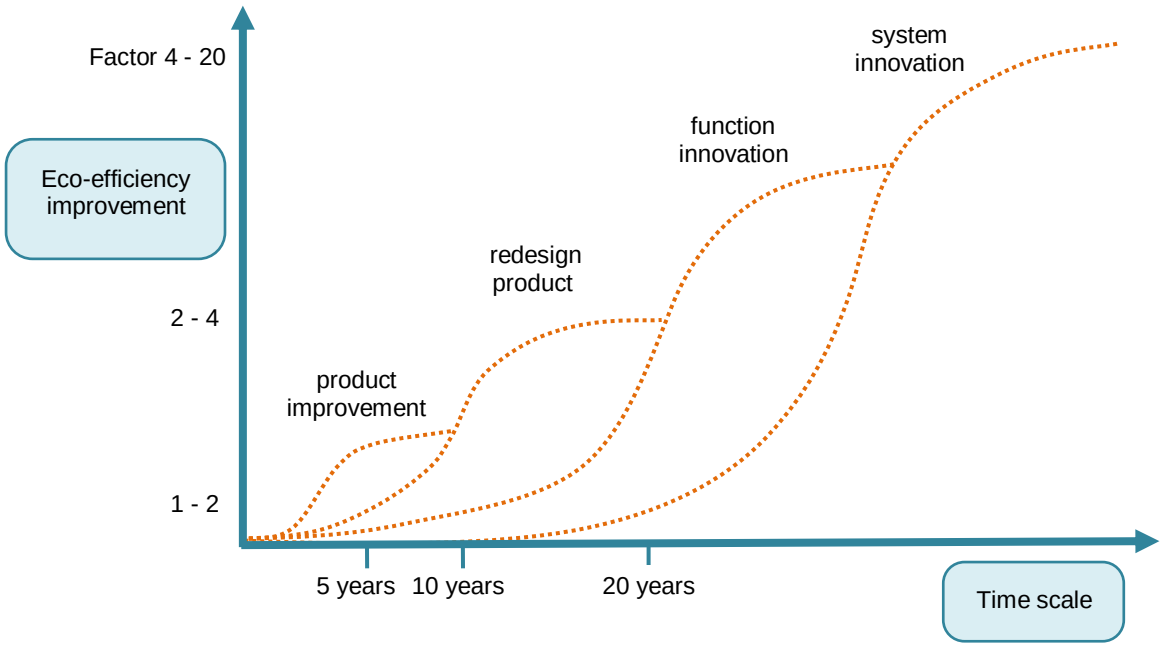

Figure 2: Four levels of environmental innovation in the way of design towards sustainability (Wilt, 1997)

With the use of design tools, designers generate ideas about possible product-service systems, visualizing and communicating them in multi-faceted lifestyles-scenarios presented in concise and visual forms that facilitate the discussion during the decision-making process. On the other hand, it can be also said that the line between function and system innovation is generally so weak that in many cases it is difficult to make a distinction between the two (examples of function innovation often imply a system modification) (Wilt, 1997).

Change in Design Paradigm

Design as the major part of the business value creation process, has to encounter the complexity of today's markets. It has to question 'what' to shape, in terms of tangible and intangible dimensions of a solution, and 'how' to do that, in terms of approaches, tools and kind of competencies involved. Originally introduced to compensate for the absence of art in the form of industrially produced products, design has long been the mediator between the natural, artificial and commercial worlds (Morelli and Loi, 2000).

Nevertheless, there were two simplified assumptions in people's mind regarding this scope: 1) it is a technical-engineering process that emphasizing on product function, 2) it is an artistic activity dealing only with color selection and materials to make a product more appealing to the eyes of customers. It should be noted, however, that in recent decades companies have understood that the design assists them to find competitive propositions and people have understood that a well-designed solution can simplify their everyday life activities because:

- Many current products present an ever-increasing number of functions and technologies. Digital products, in particular, are too often overloaded with technical specifications difficult to understand for end-users. Design, in this case, can become the key offering differentiator by virtue of its capacity to simplify and develop easy-to-use interfaces.
- Aware of markets' requirements and also sensitive to emerging social and cultural manifestations of people's needs, design is able to translate technological potentialities into commercial value propositions.
- Design has the power to make tangible and appealing the intangible by searching the aesthetic-linguistic of the immaterial and by finding ways of externalizing and communicating the functions, meanings and

values of a service performance. This is an aspect that becomes crucial in the proposition of new product-service systems, where the intangible components start to assume the same importance as the tangible elements during the customers' decision-making process before a purchase (Wilt, 1997).

It is particularly with respect to the mentioned matters that the design paradigm should respond to economic model. However, it should combine products, services and contents in order to adopt them with individual and collective needs in special socio-cultural contexts. At this point, the challenge is to establish an appropriate balance between material and immaterial aspects, global standard technologies and special local resources in order to create solutions with a unique added value as well as interesting experiences for customers. The facilitator of value creation process is the key parameter of design that can integrate different competitions that are beyond a company's boundaries. Indeed, competitive service systems cannot be run only by one company in isolation and it demands knowledge sharing among different actors as well as creativity and cooperative skills of different actors (Morelli, 2005). Within such a framework, the design is no longer a separate and independent process, but rather a team attempt nourished by designers, engineers, researchers and marketers within a creative unit (Figure 3).

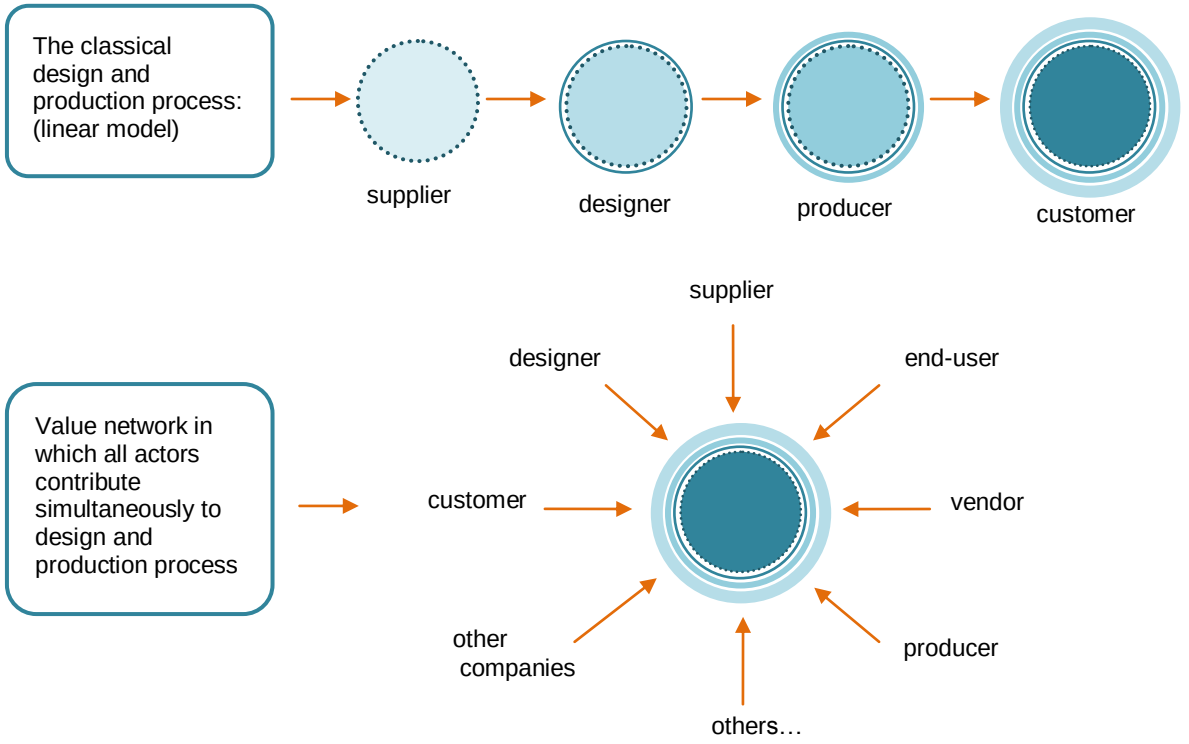

Figure 3: Difference between product-oriented and service-oriented process

The level of design innovation brought to this process may vary. It can be 'incremental': providing some improvements that 'fit in' with existing users' expectations, and which do not require behavioral changes. It can be 'radical': providing new solutions able to generate new patterns of behavior (new ways of fulfilling a need through different activities or ways of interacting with products and services). In many cases, during the creation of new product-service systems - in terms of new applications or existing applications used in a different ways - the design-driven innovation is 'radical'. This path, by requiring a certain degree of social innovation, is certainly more commercially risky, since it has to take the time necessary to establish new customer behaviors into account. However, once it is accepted, it opens strong business opportunities. Its implementation depends very much on the business attitude to the experience of a "continuous discontinuity" (Morelli, 2006), of finding ways of constantly experimenting with the 'new' and of understanding individuals, social contexts, value systems, and how these all evolve through

time (Wilt, 1997). In such a rapidly changing and complex world, no designer, engineer or architect is able anymore to know the whole system as it grows in all its details. It is innovative and more sustainable product-service systems - in terms of open, co-created and evolving systems - that seem to be potential valuable answers to these new market requirements.

The New Role of Designers

The change of design paradigms and methods will absolutely change the actor's roles of this field. Designers who once were concentrated on designing physical products are now aware that industrial systems have changed their concentration from products to knowledge-based systematic solutions including services.

However, those who operate in product field pay less attention to systematic solutions and believe that other areas such as marketing and management are responsible for service design. Accordingly, designers' activities should more concentrate on non-materialistic dimensions (such as cultural, social and economic dimensions) of production and consumption system. This is, in fact, an opportunity for companies by which they can achieve competitive advantages and find unique and individualistic solutions for customers (Morelli, 2002). According to the traditional view on design, in a society where the ownership of things and products is less important than people's access to services, designers will play a negligible role. In this condition, therefore, designers will not be related to areas like service design as well as other knowledge-based solutions. In recent decades, a large number of studies on the design have introduced services and product service systems as a particular design approach. The studies of Morelli (2001), Manzini (1993), Morlo (1995) and Pachenti (1998) are examples of these studies. On the other hand, the growth of services in a modern society emphasizes the need for a particular design culture which has not been developed yet. Margolin's (1995) definition of "*product milieu"* as the object of the design activity emphasizes the wider influence that the design activity has on each individual and society. He extends design definition to the fields which are not necessarily related to the design of materialistic products (Normann, 1996).

This new vision causes an essential promotion in designers' capability to analyze, present, understand and correct systematic elements which are not necessarily related to materialistic products. A look at this vision reveals that designers should define a new methodological approach based on the systemic view. Designers will be more engaged in this subject if they present their solutions in accordance with the infrastructure and networks of actors who form solutions. This new challenge demands a package of tools containing techniques which are compatible with and appropriate for the following problems: 1) a methodological approach which considers systematic think and 2) a special area of studies emphasizes on design within a systematic context (Morelli, 2002).

It would be useful to consider the explanation of the International Council of Societies of Industrial Design to design:

"Design is a creative activity aims to establish multidimensional qualities in products, services, procedures and systems across their life cycle…" (Kyffin, 2003).

This council states that design tries to discover and access economic, functional, organizational and structural relationships and is responsible for:

- The promotion of global sustainability and environment protection
- Providing all human societies, individuals, end users, manufacturers and marketers with benefits and freedom (social principles)
- Giving special forms to products, services and systems implying their complexity with a logical relationship with their complexity.

According to this definition, the design considers those products, services and systems that have been created by instruments, firms and logics characterizing them with industrialization [8]. Such a comprehensive definition of design extends the horizon of designers beyond the mere design of materialistic industrially manufactured products and enables them to attend in different arena that need the design thanks to the creativity element (Figure 4).

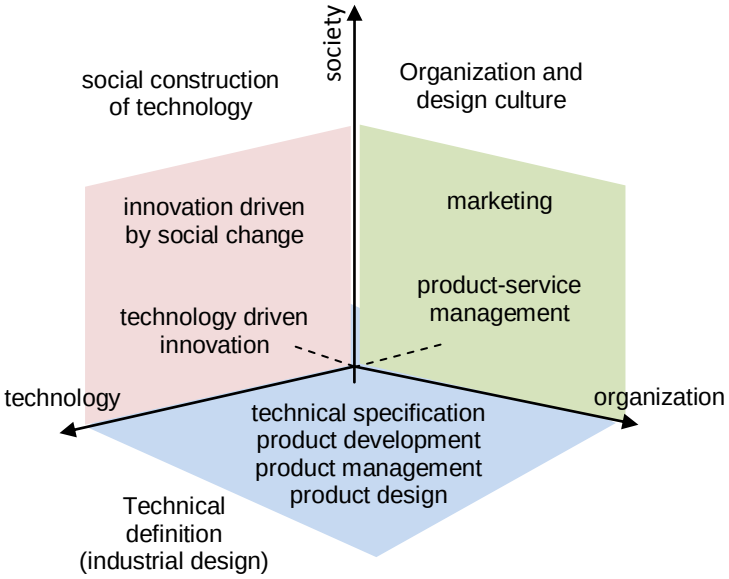

Figure 4

While the professional profile of designers in product design has been clearly developed, in the development of services different professional competences (such as marketing, management, social science) converge; different disciplines propose their own contribution, but without any attempt to define a specific design area for the design of services. Designers' capability to imagine *that-which-does-not-yet-exist* and to make it concrete as a new, purposeful addition to the real world" gives designers a good chance to play this central role in the development of innovative solutions (Normann, 1996).

Morelli provide designers with a new area of service systems design. He argues that the concentration of service systems on consumption systems demands the extension of typical design activities, which once lied between technological creativity and management, to new cultural areas where it is possible to completely understand the consumption process (Marzano, 2003). The extension of design activities to the new defined service systems introduces new elements and emphasizes on items which were considered as subsidiary items in previous design activities (Rocchi, 2005).

Manzini states that the design of new services is an activity which should be capable to link technical dimensions (the extent of our capabilities), social area (what are the clear and definite environments for demands and which one is the newest?) and cultural dimensions (what behavioral structures should be selected?) (McAloone and Myrup, 2008).

This new area introduces new challenges to designers: a) If the relationship between designers and users takes place during the direct contact with the users, the interaction between users and the service needs to be accurately planned, in order to address service needs, this means that a new design management methodology needs to be introduced, to manage the pre-definition phase of the PSS. b) Users shape the service, as well as designers and service providers do, this requires a better understanding of user's cultural, social and technological frames. c) If the service is a diachronic event, new tools need to be introduced, in order to require a better address the sequence of such events (Marzano, 2003).

Finally, it can be argued that the connection between designers and industrially manufactured products should be disrupted. In a wider vision, the design is an activity introduced to a social creativity system where manufacturing companies no longer govern the condition. Designers remake different elements within a new production process. They no longer design material products but rather, they design functional scenarios and strategies making it possible to create personal solutions for customers.

Despite of the increased demand for shifting towards solution-based production and employing combined solutions in response to customers' needs, new operators, however, have no much knowledge about designers' skill in this field. Therefore, the review of designers' competence should be considered simultaneous with increasing the demand for new solutions. At the same time, designers should learn new language and acquire new functional tools in order to operate in this new infrastructure (World Business Council for Sustainable Development – WBCSD, 1998).

RESULTS AND DISCUSSION

Results

The appearance of new environmental problems in recent years like global warming, heap of garbage, and excessive use of natural resources have increased the sensitivity of international societies to the environment. Consequently, the idea of sustainable development was introduced. On the other hand, the prevalence of consumption culture, which is an outcome of industry age, mass production and wide presence of products in markets, gradually created various environmental problems. Because the more production results in more consumption and it causes more pollution of environment, resulting in the entrance of a huge volume of waste materials to the nature. Therefore, considering the preferences of sustainable development required the change of consumption pattern in addition to the change of production processes. To this end, companies had no choice to reduce the production and consumption of physical products in order to compete with each other. In this condition, a new option was appeared: "*Service"*. So the infrastructure changed from the industry which was based on the use of natural material, to a knowledge-based industry. The output of this new industry is not physical products manufactured in linear and programmed production process but rather, it will provide customers with more solutions and makes available new capabilities for meeting customers' needs. Indeed, modern systems, composed of products and services, were appeared based on this argument that *a beneficial output is a result of value, not product*. This evolution also changes the definition, approaches and methods of design. In fact, we believe that attempts for decreasing physical products which impose serious environmental impacts to the nature, triggered the evolution of design procedure in the new age. However, this new approach was the immediate outcome of sustainable development. Other authors like Manzini, Morelli and Vezolli, who were the scholars of this field, have not identified the reasons of this change. They have only offered models and approaches to the design that can be closer to the targets of sustainability.

Eventually, due to the new wave of services, the design area had no choice to change its approaches in order to reflect to this new atmosphere. It can be argued, in fact, that the service has changed the process of design as well as the tasks of active designers in industry and business. The traditional cycle of creating value turned into a network of active operators that create value in the market by cooperating with each other. On the other hand, the emphasis of designers on the traditional method of producing physical products inhibited them from shifting to the design of service systems. But, the ability of designers in creating what that not exists as well as discovering and designing creative relationships and experiences for customers play a key role for designers in developing systematic solutions. Creativity is a key element of design by which designers can clarify unwritten and unspoken knowledge, experiences and relationships and put them within product (goods and services) framework. According to Margolin, this definition puts modern services in the design framework. Design activity is a social-individual procedure which is not necessarily led to producing a product. Sustainable design required a model which can affect both production and consumption dimensions and make change. The most difficult phase is the coordination of different socio-environmental dimensions of sustainable design. This means that, sustainable design can be put into practice only through fundamental innovations covering all production and consumption dimensions. Such an innovation is called systemic innovation or social innovation. Plural creativities are important in that, local-based and network-based activities, skills and initiatives are more effective in reducing environmental impacts than international models. Different movements have

been emerged across the world and eco-design, green design and life cycle-based design are examples of the movements.

According to above discussions, in the evolutionary process of design and production, there is a stage that can be highlighted and can be called *the 4th wave*. It initialized with the governance of handicrafts in pre-industrial age (the 1st wave) and conversion of this step to mass production during industrial age (the 2nd wave). As markets were saturated and demands for more individualistic products were increased, a new season was emerged in the design and production of products which was called customization and customer-orientation (the 3rd wave). Again, by the emergence of new technologies this movement is being changed so that by the governance of services we are experiencing the 4th wave or production sharing age where customers meet their needs by themselves and companies have been changed from producers to providers of solutions for customers.

This study tries to identify the relationships of sustainable development and design. It tries to recognize that how the targets of sustainability affect the design. According to findings, sustainability has made fundamental changes product view, necessary innovations for product design, design model and structure. The understanding of this new area and comparing its differences and similarities with previous generations, recognizing new methods appropriate with new design models and identifying their relationship with the market, industry and production are other subjects we recommend for future studies.

REFERENCES

Brezet C (1997). Dynamics in eco-design practices. *UNEP Industry and Environment* **20**(1-2) Paris: UNEP IE, 21-24.

Goedkoop MJ *et al.*, (1999). Product Service Systems, Ecological and Economic Basics, report nr. 1999/36, Den Haag: Ministerie van Volkshuisvesting. Ruitmtelijke Ordening en Milieubeheer distribution.

International Council of Societies of Industrial Design. Available: http://www.icsid.org/education/events/calendar1341, (2013).

Kyffin S (2003). The question of design. In: *The New Every day, Views on Ambient Intelligence,* edited by Aarts E and Marzano S (Koninklijke Philips Electronics, Rotterdam: 010 Publishers) 250-255.

Manzini E (1997). Short Term Strategies for Sustainability, working paper, CIR.IS, Politecnico di Milano.

Marzano S (2003). Continuous discontinuity in new value news, n.15, January issue, edited by Laura Traldi, Philips Design, Eindhoven, 10-13 (2003).

Maussang N, Zwolinski P and Brissaud D (2006). A Representation of a Product-Service System During its Design Phase –A Case Study of a Helium Liquefier. *13th CIRP International Conference on Life Cycle Engineering* 555-559.

McAloone TC and Myrup Andreasen M (2008). Defining Product Service Systems, section of Engineering Design & Product Development. Technical University of Denmark.

Morelli N (2002). The design of Product/Service Systems from a designer's Perspective. *Centre for Design at RMIT University, Australia, International Conference.*

Morelli N (2005). Design in new industrial contexts: shifting design paradigms and methodologies, in EAD. *6th EAD Conference, Bremen*.

Morelli N (2006). Globalised Markets and Localised Needs: Relocating Design Competetence in a new Industrial Context. Paper presented at *Engineering and Product Design Education Conference.*

Morelli N and Loi D (2000). Designing Product-Service Systems, A Social Construction Activity, RMIT University, Melborne, Australia.

Normann R (1996). *La Gestione Strategica Dei Servizi* (Milano: Etaslibri) 103-122.

Pine BJ and Gilmore JH (1999). *The Experience Economy, Work is a Theatre and Every Business a Stage* (Boston: Harvard Business School Press).

Rifkin J (2000). *The Age of Access: How the Shift from Ownership to Access is Transforming Capitalism* (London: Penguin Books Ltd).

Rocchi S (2005). Enhancing Sustainable Innovation by Design; An Approach to the Co-creation of Economic, Social and Environmental Value. Thesis to obtain the degree of Doctor from the Erasmus University Rotterdam by command of the rector magnificus.
Vezzoli C (2006). Design for Sustainability: the new research frontiers. *7th Brazilian Conference on Design, P & D, Curtibia* 8-11.
Vezzoli C and Manzini E (2008). *Design for Environmental Sustainability* (Springer, Italy).
Weber CM and Steinbach C (2004). Properties and Characteristics of Product Service Systems: An Integrated View. *Product Design in Changing Environment, 18-20 August, Tampere, Finland*.
Wilt C (1997). Product Stewardship at Xerox Corporation. In: *EPR: A New Principle for Product-Oriented Pollution Prevention*, edited by Davis G and Wilt C (Report, The University of Tennessee – Centre for Clean Products and Clean Technologies, Tennessee) 1-7 and 11.
World Business Council for Sustainable Development – WBCSD, (1998), Sustainability through the market, A business-based approach to sustainable consumption & production. Geneva: 1 – 11.