

SOCIOTECHNICAL ENVIRONMENTS

PROCEEDINGS OF THE 6TH STS ITALIA CONFERENCE 2016

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Smart Digital Solutions and Desirable Human–Machine Interactions: A Contribution in Terms of Design Methodology

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Digital and interactive products and services are spreading in every field of application so producing deep changes in social organizations, in the ways we perform activities, in culture and personal mental frames. The implications of the digitalization of products and systems are vast and deep, and they should be investigated and predicted within the design process; therefore, we need to upgrade the existing interaction design methodologies so to support a critical discussion on the consequences of the design choices and to manage them.

Through the discussion of some examples, the paper illustrates the vastness of the change we face.

Furthermore, the paper deals with the issue of designing innovative paradigms of interaction and presents a classification of metaphors commonly employed in application driven digital solutions and in some artistic and game design experiments.

The conceptualization of interaction design metaphors is presented as an opportunity to upgrade the interaction design methodologies.

Keywords: *Interaction design; digital design; design methodology; metaphor*

Introduction

‘We become what we behold. We shape our tools and then our tools shape us.’ This sentence, often attributed to Marshall McLuhan but more probably issued by Father John Culkin, synthesizes the issue of responsibility related to the design of new products, services and systems.

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In traditional industrial design, designers, by innovating the forms and functions of material objects, enable new ways of perform an action or activity, and produce sense and meaning effects that may have the power to induce changes on culture and ways of thinking. In the design of interactive artefacts, designers deal with the project of innovative solutions in terms of material objects as well as of services and hybrid physical/digital systems. While in the design of physical objects and spaces designers create sense and meaning effects by acting on forms, materials, appearances of material things, in the design of interactive solutions, designers also act on the shape of interactive processes, on the responsiveness of digital solutions and on procedures, so enabling new activities through the use of the digital artefacts, and new the modalities of the interactive dialogue between the machines and the human users.

The shape of the interactive processes, (i.e., the modes of engagement that the specific characteristics of a technology based interactive solution make available to the human users), triggers emotional and cognitive reactions and, as a consequence, induces new behaviours and habits, so producing changes in our mental frames, in our attitudes and abilities.

Indeed, while we design new digital devices and services, we enable new organization of human minds and abilities, and we propose new paradigms of social interaction.

From the design tradition we learned that even the simplest objects, such as a chair, can be designed in a numberless of shapes and that the 'how' of the shape can respond to a variety of logic or poetic reasons 'why'. In the same way, for each technology based object or service, the variety of possible shapes of the interactive dialogue between the human users and a machine is very ample, and we should learn how to widen our capability to explore the realm of the possible forms of interactive processes, so to produce the desired effects of emotional and cognitive engagement.

The realm of digital and interaction design is quite new and still to be explored in its functional and formal potentials: while designers have been dealing with the material attributes of physical objects and spaces for centuries, the design of the interactive solutions is still in its early phases and introduces new dimensions of project to be taken into account with specific skills and knowledge.

The new dimensions can be indicated in terms of:

- dynamic behaviors of physical and digital products;
- interactive features of the dialogue between human–machines and human–software applications;

- pro-activity of the digital solutions, i.e. the paradigms of control offered to the user vs. the models of partial and complete automation made possible by the computing capabilities of digital technologies and AI;
- paradigms of social interaction made available by the networking potentials of the internet, i.e. the new models of human–human interaction mediated by technical solutions.

So, the expressive potentials of the digital artefacts involve the dimensions of physical/spatial attributes of things and spaces (geometrical forms, technical and sensorial qualities of materials, space arrangements), and also the immaterial but very effective dimensions of the evolution in time of functionalities and of the appearance of the designed solutions, and the action/reaction dynamics within the interactive processes.

The new creative potentials offered by digital technologies pose challenges and opportunities that must be investigated through design experiences and theoretical discussion.

The present paper is based on several design, research and education experiences carried on by the author during the last few years (Conti, Pillan and Soldati, 2014; Pillan, 2015; Pillan, Spadafora and Vitali, 2014; Spadafora, 2016), and it presents some conceptual models for the different paradigms of interactions that emerge from the analysis of case studies and from design practice; the paper intends to be a contribution to the evolution of design methodologies in the field of interaction design toward a more effective and responsible approach to the use of digital technologies.

In the design history, the renewal of formal languages and of aesthetic paradigms finds its nourishment and inspiration in the critical thinking and in the discussion on the evolution of social issues, in arts and in the free, aimless, experimentation of forms. In a similar way, in the development of a design culture about technology based applications, we must develop a conversation about the implications of the formal attributes of interactive products and services on individual capabilities and on social organization.

To nourish the inspiration in the design of the formal attributes of interaction, we must ‘play’ with technologies, so to explore their creative potentials, and to understand how to create effects of sense and meaning through the shape of processes and dynamic behaviours of machines and systems.

My research and this paper intend to offer a contribution to this respect.

The thoughts reported in the paper were developed in several years of research, design and education activities during which I focused on service and interaction design topics working as professor and researcher at the

Dipartimento del Design of the Politecnico di Milano, within a research laboratory dedicated to Interaction and Experience (www.interactionlab.polimi.it). These activities also include the development of smart services and systems for public and domestic spaces in an ongoing collaboration with the 'JOL S-Cube – Joint Open Lab for Smart Social Spaces' created by TIM–Telecom Italia in Milan, and aimed to the design of mobile applications and of systems based on IoTs. Furthermore, the results here reported are also based on my activity as tutor of some PhD researches focused on the development of innovative design methodologies (Spadafora, Vitali and Pillan, 2015), and on the investigation of the creative potentials of interactive media also through the production of experimental author–games (Righi Riva, 2013; Vitali, 2017).

In the paper, through the presentation and discussion of some case studies, I provide some conceptual models that bring me to reconsider some limits of the existing mainstream methodologies for Interaction Design as a discipline, and I suggest a modified approach suitable in the design practice and in education.

The shape of interactive processes

The questioning of the medium and long term consequences associated to the adoption of digital technologies in every domain of application is important for our future and cannot be demanded to technicians only. In the course of the time, authors such as Tomas Maldonado (Maldonado, 1999; 2005) provided contributions to this purpose within a theoretical and broad vision approach; others base their research on design experiences evidencing phenomena, such as Ulrik Ekman (Ekman, 2013) who collected an ample variety of art and design experimental activities in his book 'Throughout', and demonstrated the complex ramification of this issue.

The history of the technologies and design shows a complex interdependence between the development of tools and technical solutions and the organization of a society expressed in terms of its cultural values (also including political assets and religious believes), human abilities and attitudes. The influence of design on social changes is mutual: being part of the evolving society, designers get inspiration from social and cultural phenomena, and, on their turn, give a personal interpretation and a critical reading of the changes in being, also influencing them through the innovation of visual styles and symbolic sense effects. This holds both for

traditional design (Chiapponi, 1999) as well as for Interaction Design (Telier, 2011).

While we design the functional, formal and interactive attributes of a product or of a service, we are not just designing practical solutions but we are also proposing a paradigm of solution that we consider as acceptable and desirable, and, as a consequence, we therefore produce a meme capable to reproduce itself and to propagate. As an instance, Wikipedia was not only important because its creation was a very disruptive contribution to the innovation of the traditional approaches to the collection and sharing of encyclopaedic contents, but also and mainly because it was an effective demo capable to explain and show the social advantages of collaborative activities and economy proposed as an alternative to the traditional approaches based on market competition and on top–down systems of value proposition (Tapscott, 2006).

In a similar way, as discussed by Ezio Manzini for the specific realm of social innovation, the experimental services have the power to produce cultural effects and enact changes in attitudes and cultures (Manzini, 2015). The services based on collaborative and participated involvement of final users, such as social housing systems and peer–to–peer transportation solutions, act as ‘messengers’ capable to diffuse an approach to problem solving in which customers and users are seen in terms of potential of a context and as part of the solution, and not just as recipients of a performance in response to their needs.

We should learn how to predict the long term possible consequences of our design proposals, and how to upgrade our design methodologies so to better evaluate and manage the complex tangle of side effects that are related to a specific interactive experience.

Presently, designers face the challenge of designing a new generation of physical products and systems, the so called ‘smart objects’, namely objects that can collect, store and exchange information between themselves and with human beings, and that can act, learn, evolve thanks to the gift of an artificial intelligence provided by the miniaturization of electronic devices and by mathematical algorithms.

In the following of this paper, I discuss the effects of the spreading of digital technologies on systems through three different case studies.

Transportation systems and cultural changes

As a first instance, we can consider the paradigms of most innovative advanced public transport systems proposed, between others, by XEROX.

These systems are based on the tracking of real behaviours of travellers and of traffic flows so to optimize the offer of transportation services with respect to the demand. The so called ITS– Intelligent Transportation Systems aim also to provide a seamless travel experience through a virtual integration of different transportation resources and these solutions would represent an extraordinary improvement with respect to the existing transportation systems, especially in countries such Italy, where the integration and optimization of different services is still far away. Their implementation is based on a very new approach to mobility, and it requires dynamic modelling of people needs and mathematical search for optimal solutions also considering constraints of common convenience and private vantages and interests.

The search of more sustainable and effective solutions for public transportation systems is one of the important issues for the near future and it is also a very complex one, requiring the development of a number of technical solutions for different branches of Engineering. On the other hand, the development of new paradigms of transportation services poses new design challenges since the new solutions imply radical changes in the way we conceive and access the public services: making them usable, acceptable and desirable is a complex goal requiring a multidisciplinary approach and an upgrade of the competences about experience, communication and service design.

In the present offer, most transportation services are steady both in terms of physical locations in space (busses and other vehicles runs always in the same itineraries) and in terms of time scheduling; the stability of the services provides a permanent context that contributes to the affordance of urban and suburban environments, and that allows people to plan their mobility strategies referring to a stationary representation of possibilities. The new systems, based mostly on a dynamic offer of services depending on the tracking of user behaviours and on service demands, can impact on the definition of the urban environments and on the way people will manage their personal organization schemes.

Furthermore, the dynamic public transportation services require a serious discussion about the rights of customers and especially of those minorities that do not manage dynamic interactive devices and that do not have a personal inclination toward a dynamic planning of their activities. So, actually, the creation of new transportation systems requires a better understanding of human diversity with respect to cognitive and decision making processes, and with respect to customer rights and common

convenience. The creation of the new scenarios is therefore a design and also a political challenge and as such should be intended and managed.

Digital commerce services and product quality

The topic of transport and mobility is not the only foundational system of our social organization that will be revolutionized in the next few years: the digitalization of services and systems is an opportunity to innovate a number of critical dimensions of societies, such as those related to the use of natural resources, to the reduction of wastes and pollution, and to the search of new industrial and business perspectives.

Digital technologies are deeply modifying the sale and distribution systems, where new players and stakeholders such as Amazon and the Chinese Alibaba gained influence and power without precedents acting as market places for the exchange of goods and services. These digital companies now act as central nodes of accumulation of data and offer business opportunities to big and small companies in terms of global marketplaces for big and little producers, but also are rapidly changing the rules of the business and endangering those that don't adapt their strategies to the new context.

While the advantages for customers provided by ecommerce services in terms of availability of goods are quite evident, I argue that we should be able to better understand and manage some less obvious implications.

The present organization of online service for selling goods tend to emphasize only the visual appearance of material products and their price of sale, so contributing to diffuse a very reductive common view of quality that, if not improved, will have long term consequences on industrial production. Indeed, the qualities and values of a material product depend on a much wider set of features that it is not possible to communicate through the use of a visual representation online. I refer, between others, to the haptic and thermal qualities of materials, to the performance of use, and to other characteristics such as the place and the process of production. Furthermore, while in physical retail stores the interaction between customers and sellers provide an opportunity of information exchange and knowledge growth, so producing more value associated to a product in terms of experience, in online commerce the interaction between customers and producers or sellers is mostly very basic and reduced to the essentials of the transaction process.

The creation and communication of value in the digital era requires new approaches based on a more systematic and comprehensive understanding

of the complex tangle of factors influencing the appreciation of a products or a service (Newberry and Farnham, 2013). Furthermore, while we develop innovative online services for commerce, we must also work to propose new technical solutions capable to support local retail stores and producers, and invent new quality oriented approaches to sale and interaction with customer.

In our research about digital services for retail, we are making research and experimental design activities toward two different directions: first, we are designing digital services to support little physical stores in their traditional business, so to produce for them new opportunities of business and of interaction with customers; second, we are working on the capability to communicate the physical and non-physical qualities of products, such as those concerning the fabrication processes and the values of the location of production, in the online interactions between customers and producers (Vitale and Pillan, 2016).

Smart products and personal information

To conclude this discussion about the implications of the interactive features of digital solutions, I refer to field of products and applications for personal monitoring and tracking.

Traditional personal products (such as watches, electrical appliances for domestic use, devices to access media and entertainment contents), are dedicated objects, limited in their functions and well framed in the semantic sense. The so called 'smart objects' instead, tend to include a high number of functionalities, are under the control of their human users, but also exchange information with the web, and can act in an automatic or proactive way. As an instance, we can compare a traditional alarm clock with a valuable alarm clock application such as 'Sleep cycle' or other similar solutions designed to be installed on a personal phone, that are capable to monitor the quality of sleep and to offer other features based on the collection of data provided by sensors. The smart alarm clocks can measure parameter such as breath rhythm and intensity, heartbeat rate, context noise and temperature, and also produce reports on the sleep process, comparing our performances with behaviours that are taken as a reference of normality. The applications for sleep monitoring can be interpreted as hybrid products, something in between a smart alarm clock and a care-giver. On one side, they offer innovative functionalities that can be used every day, i.e. the possibility to be waken up when the sleep cycle is closest to the awakening conditions within the predefined time range selected by

the user, so reducing the stress related to the awakening. On the other hand, they can be interpreted as a tool for health monitoring, since the application evaluates the quality of our sleep with respect to what is considered as statistical reference for wellbeing. As we turn off the alarm in the morning, we receive a feedback that increases our awareness but that can also affect the way we consider our health state. Furthermore, the capability of these applications to record personal data, memorize and share them on the web, poses the issue of privacy, that is a very complex one.

The smart products for self–monitoring provide useful tools to help us in developing a new awareness about our health conditions and lifestyle; they also provide useful information that can be employed by doctors and caregivers in the understanding the patient conditions and in the definition on therapeutic treatments. On the other hand, these new tools affect the way we feel our body and the relationship we have with ourselves.

Up to now, most design literature focuses on design methodologies and tools, and only few authors such as Anne Light and Claire Rowland (Rowland et al., 2015) offer contributions to a more responsible design of smart solutions.

While we develop and diffuse the new smart products, we should inquire and criticize their potential invasiveness and try to predict their long term effects. The tendency to overindulge in the number of functions embedded in a smart product is quite diffused: the concentration of functionalities affects the complexity of their use but also the quality of the experience and, potentially, our lifestyles. This trend should be better discussed in terms of desirable lifestyles and design principles.

Metaphors for interaction design

The opportunity of creating physical and virtual products that can act as active or pro–active entities is quite new in the history of human beings. On the other hand, as it is documented by a well know passage of the Greek poem Iliad, describing the two golden–robot maidservants supporting Hephaestus (Iliad, vv 417–421), human beings have always pursued the dream of building intelligent machines so to solve practical needs, but also to be delighted by pseudo–social interaction with perfect entities.

Now, the evolution of technologies makes feasible the creation of solutions capable to exchange information with us, to memorize our preferences, to anticipate our requests and to act in an autonomous way.

So, the question is: what kind of personality do we want to give to the machines we design? How can we invent new styles for interaction as we do with the material attributes of physical objects?

In the design of a material objects, such as a chair, the designer is oriented in the project activities by the practical constraints and by formal/aesthetic intentions. The complex of the requirements can be effectively synthesized by a metaphor that orients the development phases: for instance, designers designed the chairs that were *light as a feather*, or *vanishing like a ghost*, or *sensuous as a caress*.

In the design of the possible shapes of the interactive dimension of a smart product or of a service, we should be able, likewise, to imagine different possible solutions and to define suitable metaphors acting as compasses so to orient the definition of the main features of the interaction as well as the physical implementation details (Spadafora, 2016). We take as a reference, the MIT studies demonstrating that humans tend to consider proactive objects as living entities (Reeves and Nass, 1996). We designed a control panel to adjust the temperature also managing the conflictual trade off between wellbeing and energy saving (Vitali et al., 2014). We designed playful artefacts capable to tackle cognitive dissonances and to produce the experience of meaning construction through interactive engagement (Pillan et al., 2011; Vitali, 2017).

As a result, we can classify the main metaphors that characterize most of the analysed case studies into two main categories: those oriented toward function and efficiency performances, and those aimed to produce an aesthetic effect through interactive engagement.

In the first category, the design of interaction is guided by a metaphor in which the technical system is interpreted as mechanical machine, activated through triggers, and obeying to orders activated by a limited number of possible choices offered to the users in terms of commands such as:

- Cause and effect (if ... then... else...);
- Automation (do it for me);
- Reduce my physical and cognitive efforts;
- Force me to do it in this way;
- Challenge and award me;
- Drive me through an interactive experience so that I learn by doing.

The second category includes solutions in which the user is enabled to act in open-end interactions and that produce effects such as:

- Elicit my senses and emotions;
- Astound me and provide a completely new experience;

- Talk to me of something that is deeply buried inside me;
- Recover a meaningful piece of my memory;
- Challenge my brain;
- Through interactive experiences, allow me to develop better awareness of the virtual and physical world (open conclusions);
- Create open interactive contexts where I can create my personal experience (fostering ambiguity).

The metaphors of the first category drive the development of solutions such as the smart refrigerators, smart lighting and heating systems, and of locking solutions. These new devices are capable to act instead of us, and to suggest a ‘convenient’ behaviour. They include domestic appliances that can compile the list of goods that should be bought or send the order of purchase to Amazon, that can optimize our energy consumption, support our memory recalling the agenda of the day, and that will be able to drive us at work while we dedicate our attention to other tasks. This first category is today the dominant one, it produces useful functionalities but also a number of technological solutions that, despite their apparent practical utility, are unable to encounter the appreciation of users and that have hidden implications that should be better understood and managed.

The second category is much less consistent from the point of view of the number of available case studies, and includes poetic concepts such as ‘A chair with a Soul left behind’ and ‘Personal Skies for Workshperes’, developed by Naoto Fukasawa and presented at the MOMA in New York, and games such as ‘The Graveyard’ by the Tale of Tales, and ‘Wheels of Aurelia’ by Santaragione.

In the whole, these examples demonstrated that there are ample possibilities of shape the interactive features of digital technologies so to create meaningful design solutions also qualified in terms of sensorial and symbolic results.

Upgrading Interaction Design Methodologies

The development of interactive products and services is, most of the times, a multidisciplinary processes requiring the collaboration of designers with engineers and other experts of technology. The canonical approach to this kind of projects is based on cyclic iteration of activities including user studies, the generation of new concepts, the design of physical characteristics, the prototyping and testing. The focus is on the design of

useful new functionalities and on making them accessible, acceptable and usable.

This approach is vastly adopted for the project of little products and of complex systems. On the other hand, despite the robustness of the methodology, the failure rate of new concepts is still very high and, in several fields such as home automation, the new solutions still struggle to obtain the consensus of users, despite the apparent utility of the proposed solutions. As designers, even in the design of digital interactive products and services, we should focus on the 'shape' of the interactive processes enabled through technology, and not just on functionalities.

The tools we need are already there: the ability to envision scenarios through storytelling, video making, customer journeys, visualization process, worst case analysis, and more, are part of the standard technical skills for designers, together with the abilities to criticize existing solutions and to propose innovative concepts. What we need, is the capability to invent new paradigms for interaction and to develop an awareness of the Importance of the formal qualities of it.

The explicit representation of the design metaphors associated to the different shapes of interactions, as discussed above, offers the opportunity to make evident the implications of choices in terms of design and social meanings and consequences and, therefore, it provides a tool for the upgrading of the design practice.

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