CLUSTER ACCESSIBILITÀ AMBIENTALE

a cura di / edited by
Adolfo F. L. Baratta, Christina Conti, Valeria Tatano

ABITARE INCLUSIVO

Il progetto per una vita autonoma e indipendente

INCLUSIVE LIVING

Design for an autonomous and independent living

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Società Italiana della Tecnologia dell'Architettura

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UNIVERSITÀ DEGLI STUDI DI UDINE

Università Iuav di Venezia

ROMA TRE UNIVERSITÀ DEGLI STUDI

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Inclusive Design Approach in Assistive Technology Development

Approccio progettuale inclusivo per lo sviluppo di tecnologie assistive

The Inclusive Design approach is a key point in the development of consumer products, the more people can use a product, the more chances of market success it has. The design thinking approach to product development through trial and error processes, starting from field research, focusing on user needs and reaching user-friendly results, is now the driving force of research and design practices.

Furthermore, the diffusion of low-cost electronics and the easy access to the knowledge of ICT technologies allow more designers to creatively deal with the difficult scenarios of assistive technologies. The future generation of designers will face faster growth of ICT embedded in consumer products, and this could be a good opportunity for Inclusion

This paper presents six examples of Inclusive Design products developed involving disabled users and through hands-on approach. Products have been developed by design students of the Product Design Laboratory during 2018-2019 academic year.

The paper focuses on the user centered design approach as the best one to design a product for a real user affected by a disability; indeed, according to the teaching strategy, students identified a person with a disability and then worked together to identify a need and create a functional prototype of a product that can help the user with a specific task.

The projects have been developed through the application of desktop research, user involvement, mock-ups and each final working prototype. The results of the process have been exhibited to the general public at the end of the semester.

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Introduction

Inclusive Design Approach is a key point in the development of consumer product, moreover the accessibility of low-cost electronics and the ease of access of these technologies allow more designers to face themselves within the challenging scenarios of assistive technologies. Design thinking dynamics for product development, starting from on-field research and focusing on the user needs through trial and error processes, are today drivers for the design research and practice, and consist in an important ground for the growth of future generation of designers.

The attention on the consistency of designed objects and spaces has become relevant in the recent years focusing both on the environmental impact of the designed products (Thackara, 2006; The Ellen McArthur Foundation), as much as on the impact on the human brain and behavior (Mallgrave, 2013).

The main goal of the design of living spaces, houses and environment for elderly or disabled people is generally to improve autonomy and independence in carrying out both ordinary activities and specific tasks related to particular conditions, limitations or dependencies. Recent ICT developments in ICT in buildings and interior design but also applied to personal devices design for health care and wellness led to the definitions of "Ambient Assisted Living" (Röcker, 2011; Susnea *et al.*, 2012; Bevilacqua *et al.*, 2014; Losco *et al.*, 2017) and "AmI - Ambient Intelligence"(Becker *et al.*, 2006; Cooky *et al.*, 2007), that are growing fields of the design focused on living spaces for people with specific needs, disabled or elderly.

As evidenced by Güldenpfennig *et al.* (Güldenpfennig *et al.*, 2019), in Assistive Technology Design, autonomy and independence are often equated but they are not; indeed, autonomy for people with specific needs is not only independence but it also includes further notions such as individual freedom, privacy, free choice, self-governance, self-regulation, moral independence and it can be divided into short-term and long-term needs/resources management (Güldenpfennig *et al.*, 2019; Laurìa *et al.*, 2019). For almost all of these notions we can say there are specific assistive technologies based design solutions for which are required specific design expertise and prototyping skills; this is mainly because of the variety and heterogeneity of end users and because of several novel paradigms such as "low-cost" and "Open Source". As for disability situations, some recent research (Calvo and Johnson, 2014; Güldenpfennig *et al.*, 2019) report a growing open-mindedness of users in adopting new ICT based and physical computing based tools (robotics, smart objects, smart gadgets; Schmitz, 2010; Röcker, 2011; Bevilacqua *et al.*, 2014; Krajewski, 2017), as well as in using modular technological solutions and/or systems aiming to achieve a more customized solution, also with a self-construction approach. Even not going to self-construction, personalization of objects, environments and systems gains special relevance (see Calvo and Johnson, 2014; Laurìa *et al.*, 2019) both because of users peculiarities and the need to better control the different aspects of the designed solution; this, indeed, increases a lot the perception of autonomy and awareness about tools potential.

As we can guess, the range of this kind of products has rapidly grown and several new types of smart-objects have been introduced in addiction of existing consolidated products in the fields of domotics, healthcare and biomedical. New products that have fueled the market takes names like "Smart homes", "life gadgets", "smart artefacts", "wearable/smart clothes", in a word: "smart objects", mostly having a common intrinsic element: the capability to acquire, process, display data (Bevilacqua *et al.* classify up to 68 types of different data; Becker *et al.* talks about "Intelligent fusion of multimodal sensor values" – Becker *et al.*, 2006; Cooky *et al.*, 2007; Bevilacqua *et al.*, 2014) and to activate mechanisms or functions thanks to embedding of miniaturized computers.

However, we can add a further characteristic – in this case exogenous – the "intuitive" or "natural" interface and "unobtrusive" design (Becker *et al.*, 2006; Cooky *et al.*, 2007), which must be provided by the design stage as it is highlighted by the large amount of studies focus-

ing natural man-machine multimedia communication and interaction with anthropomorphic robots (Schmitz, 2010).

Smart tools and related context: ecosystems of connected objects

The Design Thinking approach has been used for many years in different fields of application and it concerns products whose spatial context varies from the micro scale (objects) to the wider scale (parts of the territory). Using ICT and other novel resources and techniques in producing consumer goods actually makes it increasingly difficult to give a spatial / dimensional "scale" to new design products since they can be sometimes miniaturized and also part of an extended system or, on the opposite, a complex and spatially extended system made by small household or personal devices (e.g. IoT). Often an ICT-enabled product is therefore part of a complex unified designed "ecosystem" made by elements which can also be individually produced and modified later. (Krajewski, 2017; Bassi, 2017).

Hence, the dimensional scales of the ICT-enabled design products goes from the miniaturized or wearable objects, to portables or households, furnishing, homes and buildings up to the neighborhood, city and the wide territory; therefore new designers must design micro-scale objects dealing with macro scale systems mastering traditional techniques and materials as well as digital networks, computers and software, since often they cannot be limited to deal with other professionals and experts, much more they must undertake a rapid prototyping stage.

Data and information accessibility

Nowadays, the role information – and digital information – takes on an unprecedented relevance in design of products for vulnerable people such as children, elderly or disabled. Assistive technologies are by now a wide collection of objects, systems and solutions aimed at improving the living conditions of people experiencing different kind of limitations using various electronic and IT tools that can now be applied in a pervasive way. The enabling factor is almost always the availability of a network connection and/or the Internet, while personal smart devices such as mobile phones, watches, home/home automation devices etc. can be considered strong "accelerators". In all the cases listed, the determining factor for innovation is the acquisition, processing and display of digital data and information.

As in other fields, even for assistive technology products, the combination of these factors leads to the growth of new communities that interacts within a social network (Susnea *et al.* 2012) which takes on a dual value: on the one hand they give to users with reduced mobility or social relationship access to useful information and important contacts, on the other, according to the well-known paradigm of the Open Source, they become relevant repositories of information and instructions to develop the same assistive technologies they use to interact or even new tools to enhance their capabilities.

Knowing and teaching the Inclusive Design Approach

The outlined scenario is characterized by many facets of the notion of inclusiveness and autonomy, different features regarding needs of users, continuous evolution of technological tools and methods; everything strongly underline the need for specific design expertise and skills for professionals capable of developing different solutions in a systemic way properly integrating various components, materials, technologies and production systems. In all this, moreover, fast prototyping becomes from optional phase to essential element of product design. It's increasingly evident that the designer's paradigm has already changed from creator of single products to a designer of services and systems that lead him to explore previously unknown fields of application. Among the main drivers of this change process we can certainly put the evolution of digital

technologies, but probably also the increasing complexity of human lifestyle in urban contexts, of products and services supply and the media system has played a primary role; as a matter of fact, these factors take a relevant part to the evolution of the socio-economic system in which products are often part of a complex process that links them to other products, both tangible and intangible, that have to be designed almost as a single item.

The depiction of this scenario is further strengthened by the rise of new methodologies and fields of design (Inclusive Design, User Centered Design, Ambient Assisted Living, etc.) for many of which literature and research highlights the need for multidisciplinary and multisectoral approaches. (Losco *et al.*, 2017; Bassi, 2017).

Inclusive Design Approach, in particular, is therefore a key point in the development of consumer product, moreover the accessibility of low-cost electronics and the ease of access of these technologies allow more designers to face themselves within the challenging scenarios of assistive technologies. Design thinking dynamics for product development, starting from on-field research and focusing on the user needs through trial and error processes, are today drivers for the design research and practice, and consist in an important ground for the growth of future generation of designers.

Assistive Technologies Design Laboratory at Iuav University of Venice

In the present paper, we collected a set of products developed within the Assistive Technologies Design Lab of Iuav University of Venice. The laboratory is a practical course that aims to introduce the students to the world of open source assistive technologies, enhancing their awareness of the possibilities and the impact that technologies can do when properly designed for inclusive purposes. A first-year experience has been described in precedent works (Romero *et al.*., 2018).

The approach adopted for the teaching includes theoretical frontal lessons on basic electronics and coding and practical activities for which the students are asked to develop an hands-on attitude towards product development. Lessons were held one day and a half for each week, the contents were adapted to the students' needs and requests for deep understandment. Furthermore, they could find support during the week attending the FabLab space, in which Arduino boards, electronic components and tools were open to use.

The students were divided in groups of 5-6 persons and, after a short "warm-up" project, they have been focused in a second project in the Inclusive Design field, namely assistive technology devices. Students had to identify, contact and involve a user with a disability (or the caregiver of this user). For this specific stakeholder, students had to design a technological assistance device. After the definition of the projects' topics followed a series of intervention from caregiver, relatives or patients associations hosted during the laboratory.

Results, inclusive design projects examples

1) Wave: an IoT system for orienteering of blind users in Venice

Wave project focuses on the possible application of RFID technologies in the urban path of Venice, to help blind users to orientate autonomously and reducing the need of assistance. The system consists in an handle to add to the stick and a set of unobtrusive RFID tags to be placed on the city walls and streets to point relevant information on the path. The handle includes speakers and buttons that allows to recognize the tags along the path, so the user can record the relevant ones and receive an audible feedback and an haptic feedback about the need to turn left or right. The project has been developed in strict collaboration with a blind person, who particularly appreciated the result because found it a mean of claiming his independence, being allowed to faster recognize paths without having to fully

Fig.01 Mock-up for the ergonomics of the "Wave" stick handle.

memorize them with no external helps, wandering through such a complex city as Venice. Paths and attached information can also be shared with other blind persons through the Wave web portal that stores all the tags and data recorded by each user.

Wave is a clear example of Product/Service system composed by smart objects and social-network-enabled product aimed to extend inclusivity from user's home to the urban space. Wave shows also how improper can be trying to define a "spatial scale/dimension" of such a design product since even the number of devices and users is unknown and considering the concept of a continuous spatial growth of the system.

2) Dìa: a smart glucometer for the measurement and data log

Dìa is a device that aims to include in a single element a set of functions and tools needed by diabetic persons, such as the glucometer, the needles, the lancets, the cotton and a little trash storage. The device was developed after an on-line survey about similar products from which the group decided to focus on the cases of two young women affected by diabetes A. The project incorporates different elements in an single box aiming to reduce the amount of devices a person should carry on. Dìa glucometer is based on an existing open-source project; it has been re-designed in terms of ergonomics and includes an immediate visual feedback represented by three lights (red, white and green LED), whilst the main communication function is transferred on a smartphone application. The mobile app was built to show the exact value after each measurement, to storage the records and to visualize their variation in time. The visual translation of the data collected was meant to be a self-empowerment of the user, that could feel the consciousness of her own health status, but also a tool to send and transfer quick alerts to the general practitioner if medical support was needed.

Dìa is a smart object that improves both autonomy about health monitoring and information sharing with user's doctor or family. Diabetes is a disease for which frequent monitoring and analysis of measured values in near real time can be crucial; at the same time, Internet data sharing can improve user's life quality reducing the need of visits and examinations outside home. Dìa has been developed as an open-source product helping users to auto-produce a device which can be quite expensive if purchased on the market.

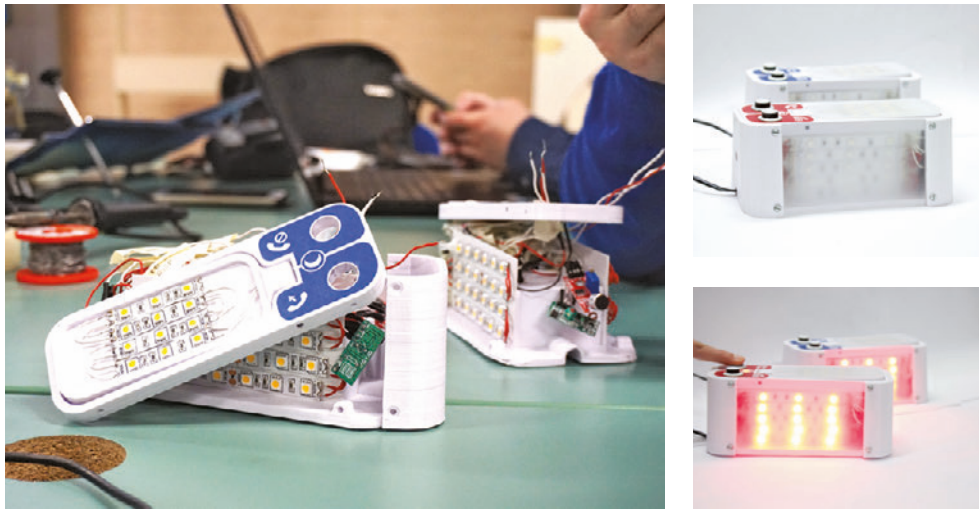

Fig.02 Ear2Eye - Work in progress of the model and example of use.

3) Meridiana: a device for the management of time for users affected by Alzheimer

Meridiana is a wall element that provides a set of information to the users, developed to communicate time and weather conditions to the inhabitants of a special elderly care facility. In fact, the environment of destination for the device is a community that hosts persons in an early stage of Alzheimer's disease, where the facility is built to simulate a neighborhood in which the hosts can move without restrictions and feel in a familiar environment. Meridiana provides a set of lights that show the passing of time and a background illumination that recalls the season, plus invites the users to interact by pressing the buttons located in the front part, that provide information about the date, the daily events, the weather conditions with some suggestion on clothing, and the temperature.

Meridiana is a relevant example of Ambient Assisted Living device that aims persons to access important information about events of the day. Research about natural designed interface is one of the key points of this project as well as the ICT system that manage the events database as a clear example of crucial importance of access of useful information for people with special needs.

4) Ear2Eye: a device for in-house communication with deaf users

Ear2Eye is a system developed for deaf users who might not perceive due to a temporary absence of the hearing aids aiming to provide them a visual feedback to environmental sounds. Ear2Eye is a further example of system of smart objects consisting in a set of lamps with lights of different colors and buttons: buttons allow devices to communicate to each other, while lights switch on in response to the press of the buttons or to specific environmental sounds, such as the ringing bell, the alarm, the phone. Ear2Eye system is developed for a domestic use, considering the familiar environment in which the deaf users might find the confidence to stay without hearing aids, but still provides a visual feedback that allows their interaction with the surroundings, being aware of other people's presence and feeling included in the daily living.

Ear2Eye is a system aiming to improve deaf persons independence filling the gap about situations in which they does not wear their hearing aids. It's a further example of Ambient Assisted Living based on the idea of "putting a bridge" between the two human senses, sight and hearing.

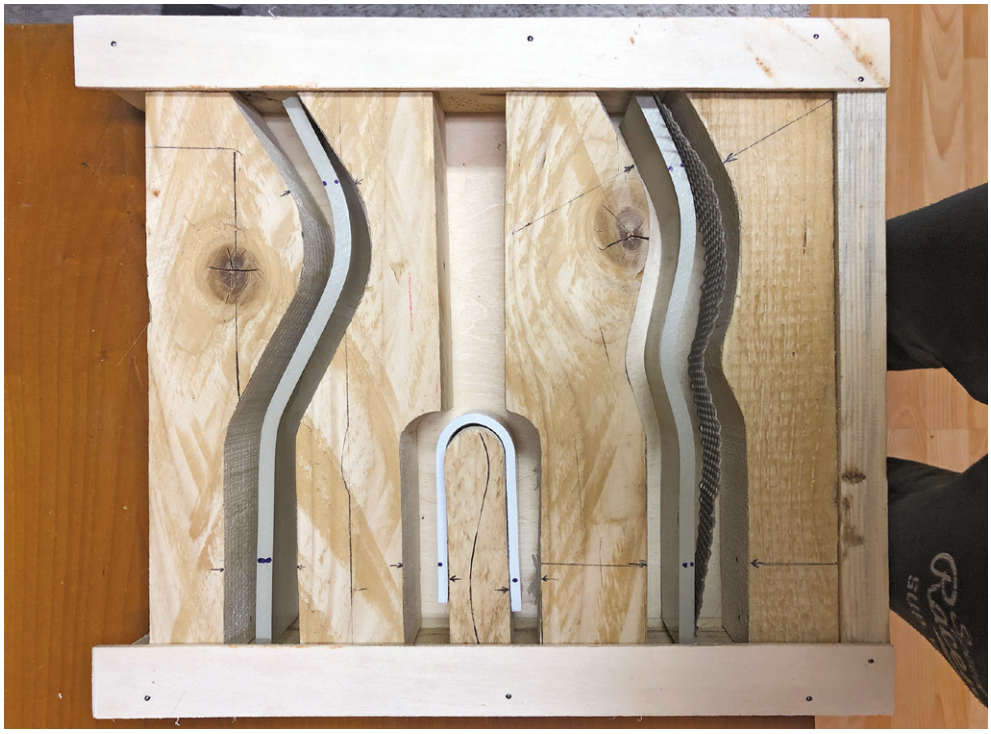

Fig.03 Protium, mold and set of prototypes.

5) Warni: a night-call device for ALS patients

Warni project was developed to answer the need of communication between users affected by ALS and their caregivers. In particular, the project focuses on the night shift, when most of the communication devices are switched off, therefore the patient remains unable to communicate a need or send any alarm. Warni is a single, simple and flexible device that detects a particular eye movement and sends an alert to the caregiver's smartphone allowing a valid and immediate feedback to the patient's call even if the caregiver is in a different room or far from the patient's bed.

As written before, research about Assistive Technologies highlighted the need to focus on caregiver's needs as well as for the patient. Warni is a further Ambient Assisted Living product in which low-cost, self-production and open-source approaches are founding paradigms and autonomy/independence improvement is related both to caregiver freedom and to patient's privacy needs.

6) Protium: a low-cost prosthetic foot for children

Protium is a project that addresses inclusivity under different aspects: first, the design of a prosthetic element for children, allowing them to move with freedom despite the loss of the limb; second, the accessibility of a durable product in a difficult environment. The decision of the team to get inspired by Emergency's e Sulaymaniyah Rehabilitation And Social Reintegration Centre in Iraq has determined the product features and main requirements: object of the design was not only the development of an efficient prosthetic element, but the entire process of realization, allowing the local production with simple machines that exploit plastic wastes.

Protium addresses sustainability other than inclusivity as it designs an assistive device in

Fig.04 Protium, mold and set of prototypes.

its entirety, from materials and shapes, to the whole production process, in strict accordance with open-source, self-production and low-cost approaches but also with the emerging circular economy paradigm.

Conclusions

Inclusive Design approach, and specifically Assistive Technology product development focus has been a good opportunity to address students in a End-User involvement experience.

In addition to the professional knowledge acquired, many students had the opportunity to have direct contact with disabled people for the first time. This situation has brought awareness to the possible impact of the product designer's work. The design and creation of a more inclusive society also depends on the knowledge that every designer must have on the needs of people with disabilities. By choosing design exercises concerning the world of disability, the teachers of this course wanted to make a small contribution to the general awareness of the importance of considering disabled people as part of our society.

The field of Assistive Technology has been proposed 2 academic years consecutively (2017-19), at the end of each course the teaching method has been evaluated by the students, to whom was subdue a standard questionnaire. Furthermore, students were asked to evaluate anonymously their group mates.

Thanks to the 30 voluntary answers in two years, we understand that the students of both years agree on the high commitment required to attend the course, but they find the teaching valid and useful in terms of their own preparation. The group structure for the projects was appreciated both years and the group mate evaluation has been considered more influential in the second year. The economic effort required through the course for the acquisition of the

materials for prototype making has been addressed as a main issue both the years, focusing on the waste caused by a lack of preliminary knowledge by the students that are inclined to buy an excess of materials they will use in small quantity or not use at all. The institution of a laboratory open to the students has been relevant in terms of tools and space for experiments and prototyping, conveying their work and creating a room for discussion and active confrontation. The overall judgement on the course was positive, despite not distant from the opinions collected in the previous year.

Further steps

In the next future, teaching staff plans to disseminate results of the course through the POSTA platform, a repository of Open Source Assistive Technology projects (www.postaproject.org). The aim of the platform is to match offer and demand of Assistive technology projects offering all the needed knowledge with creative common policy.

Furthermore, in some cases, user involved in these processes are strongly interested in develop the prototypes in ready-to-sale products.

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Il volume affronta il tema dell'abitare presentando i risultati di studi, ricerche e sperimentazioni di architettura in chiave inclusiva, raccolti in occasione del convegno dal titolo "Abitare inclusivo" organizzato a Udine nel 2019. Il progetto che ha reso possibile questa antologia strutturata di esperienze nasce dalla volontà dei componenti del Cluster Accessibilità Ambientale della Società Scientifica della Tecnologia dell'Architettura (SITdA), di rilevare un modello funzionale attuale di riferimento scientifico interdisciplinare dell'architettura, declinato alle diverse scale delle opere, dei prodotti e dei processi, per l'avanzamento tecnologico di una progettazione sempre più mirata alla persona e al suo valore in un processo etico di sviluppo sociale.

The volume deals with the issue of living in an inclusive point of view by presenting the results of contributions, research experiences and design experiments collected at the international conference "Inclusive Living" organized in Udine in 2019. Starting from the will of the Accessibility Cluster of the Italian Society of Architectural Technology (SITdA), this structured anthology of experiences aims to define a functional, interdisciplinary and scientific reference model in the field of architecture. This has to be declined at different scales of works, products and processes so it can guarantee the technological progress of a design that is increasingly targeted to the person and its value into an ethical process of social development.

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