Aaron Marcus
Elizabeth Rosenzweig
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Design, User Experience, and Usability

12th International Conference, DUXU 2023
Held as Part of the 25th HCI International Conference, HCII 2023
Copenhagen, Denmark, July 23–28, 2023
Proceedings, Part I

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Aaron Marcus · Elizabeth Rosenzweig ·
Marcelo M. Soares
Editors

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Editors
Aaron Marcus
Aaron Marcus and Associates
Berkeley, CA, USA

Marcelo M. Soares
Southern University of Science
and Technology – SUSTech
Shenzhen, China

Elizabeth Rosenzweig
World Usability Day and Bubble Mountain
Consulting
Newton Center, MA, USA

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Foreword

Human-computer interaction (HCI) is acquiring an ever-increasing scientific and industrial importance, as well as having more impact on people's everyday lives, as an ever-growing number of human activities are progressively moving from the physical to the digital world. This process, which has been ongoing for some time now, was further accelerated during the acute period of the COVID-19 pandemic. The HCI International (HCII) conference series, held annually, aims to respond to the compelling need to advance the exchange of knowledge and research and development efforts on the human aspects of design and use of computing systems.

The 25th International Conference on Human-Computer Interaction, HCI International 2023 (HCII 2023), was held in the emerging post-pandemic era as a 'hybrid' event at the AC Bella Sky Hotel and Bella Center, Copenhagen, Denmark, during July 23–28, 2023. It incorporated the 21 thematic areas and affiliated conferences listed below.

A total of 7472 individuals from academia, research institutes, industry, and government agencies from 85 countries submitted contributions, and 1578 papers and 396 posters were included in the volumes of the proceedings that were published just before the start of the conference, these are listed below. The contributions thoroughly cover the entire field of human-computer interaction, addressing major advances in knowledge and effective use of computers in a variety of application areas. These papers provide academics, researchers, engineers, scientists, practitioners and students with state-of-the-art information on the most recent advances in HCI.

The HCI International (HCII) conference also offers the option of presenting 'Late Breaking Work', and this applies both for papers and posters, with corresponding volumes of proceedings that will be published after the conference. Full papers will be included in the 'HCII 2023 - Late Breaking Work - Papers' volumes of the proceedings to be published in the Springer LNCS series, while 'Poster Extended Abstracts' will be included as short research papers in the 'HCII 2023 - Late Breaking Work - Posters' volumes to be published in the Springer CCIS series.

I would like to thank the Program Board Chairs and the members of the Program Boards of all thematic areas and affiliated conferences for their contribution towards the high scientific quality and overall success of the HCI International 2023 conference. Their manifold support in terms of paper reviewing (single-blind review process, with a minimum of two reviews per submission), session organization and their willingness to act as goodwill ambassadors for the conference is most highly appreciated.

This conference would not have been possible without the continuous and unwavering support and advice of Gavriel Salvendy, founder, General Chair Emeritus, and Scientific Advisor. For his outstanding efforts, I would like to express my sincere appreciation to Abbas Moallem, Communications Chair and Editor of HCI International News.

July 2023 Constantine Stephanidis

HCI International 2023 Thematic Areas and Affiliated Conferences

Thematic Areas

- HCI: Human-Computer Interaction
- HIMI: Human Interface and the Management of Information

Affiliated Conferences

- EPCE: 20th International Conference on Engineering Psychology and Cognitive Ergonomics
- AC: 17th International Conference on Augmented Cognition
- UAHCI: 17th International Conference on Universal Access in Human-Computer Interaction
- CCD: 15th International Conference on Cross-Cultural Design
- SCSM: 15th International Conference on Social Computing and Social Media
- VAMR: 15th International Conference on Virtual, Augmented and Mixed Reality
- DHM: 14th International Conference on Digital Human Modeling and Applications in Health, Safety, Ergonomics and Risk Management
- DUXU: 12th International Conference on Design, User Experience and Usability
- C&C: 11th International Conference on Culture and Computing
- DAPI: 11th International Conference on Distributed, Ambient and Pervasive Interactions
- HCIBGO: 10th International Conference on HCI in Business, Government and Organizations
- LCT: 10th International Conference on Learning and Collaboration Technologies
- ITAP: 9th International Conference on Human Aspects of IT for the Aged Population
- AIS: 5th International Conference on Adaptive Instructional Systems
- HCI-CPT: 5th International Conference on HCI for Cybersecurity, Privacy and Trust
- HCI-Games: 5th International Conference on HCI in Games
- MobiTAS: 5th International Conference on HCI in Mobility, Transport and Automotive Systems
- AI-HCI: 4th International Conference on Artificial Intelligence in HCI
- MOBILE: 4th International Conference on Design, Operation and Evaluation of Mobile Communications

List of Conference Proceedings Volumes Appearing Before the Conference

1. LNCS 14011, Human-Computer Interaction: Part I, edited by Masaaki Kurosu and Ayako Hashizume
2. LNCS 14012, Human-Computer Interaction: Part II, edited by Masaaki Kurosu and Ayako Hashizume
3. LNCS 14013, Human-Computer Interaction: Part III, edited by Masaaki Kurosu and Ayako Hashizume
4. LNCS 14014, Human-Computer Interaction: Part IV, edited by Masaaki Kurosu and Ayako Hashizume
5. LNCS 14015, Human Interface and the Management of Information: Part I, edited by Hirohiko Mori and Yumi Asahi
6. LNCS 14016, Human Interface and the Management of Information: Part II, edited by Hirohiko Mori and Yumi Asahi
7. LNAI 14017, Engineering Psychology and Cognitive Ergonomics: Part I, edited by Don Harris and Wen-Chin Li
8. LNAI 14018, Engineering Psychology and Cognitive Ergonomics: Part II, edited by Don Harris and Wen-Chin Li
9. LNAI 14019, Augmented Cognition, edited by Dylan D. Schmorrow and Cali M. Fidopiastis
10. LNCS 14020, Universal Access in Human-Computer Interaction: Part I, edited by Margherita Antona and Constantine Stephanidis
11. LNCS 14021, Universal Access in Human-Computer Interaction: Part II, edited by Margherita Antona and Constantine Stephanidis
12. LNCS 14022, Cross-Cultural Design: Part I, edited by Pei-Luen Patrick Rau
13. LNCS 14023, Cross-Cultural Design: Part II, edited by Pei-Luen Patrick Rau
14. LNCS 14024, Cross-Cultural Design: Part III, edited by Pei-Luen Patrick Rau
15. LNCS 14025, Social Computing and Social Media: Part I, edited by Adela Coman and Simona Vasilache
16. LNCS 14026, Social Computing and Social Media: Part II, edited by Adela Coman and Simona Vasilache
17. LNCS 14027, Virtual, Augmented and Mixed Reality, edited by Jessie Y. C. Chen and Gino Fragomeni
18. LNCS 14028, Digital Human Modeling and Applications in Health, Safety, Ergonomics and Risk Management: Part I, edited by Vincent G. Duffy
19. LNCS 14029, Digital Human Modeling and Applications in Health, Safety, Ergonomics and Risk Management: Part II, edited by Vincent G. Duffy
20. LNCS 14030, Design, User Experience, and Usability: Part I, edited by Aaron Marcus, Elizabeth Rosenzweig and Marcelo Soares
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23. LNCS 14033, Design, User Experience, and Usability: Part IV, edited by Aaron Marcus, Elizabeth Rosenzweig and Marcelo Soares
24. LNCS 14034, Design, User Experience, and Usability: Part V, edited by Aaron Marcus, Elizabeth Rosenzweig and Marcelo Soares
25. LNCS 14035, Culture and Computing, edited by Matthias Rauterberg
26. LNCS 14036, Distributed, Ambient and Pervasive Interactions: Part I, edited by Norbert Streitz and Shin'ichi Konomi
27. LNCS 14037, Distributed, Ambient and Pervasive Interactions: Part II, edited by Norbert Streitz and Shin'ichi Konomi
28. LNCS 14038, HCI in Business, Government and Organizations: Part I, edited by Fiona Fui-Hoon Nah and Keng Siau
29. LNCS 14039, HCI in Business, Government and Organizations: Part II, edited by Fiona Fui-Hoon Nah and Keng Siau
30. LNCS 14040, Learning and Collaboration Technologies: Part I, edited by Panayiotis Zaphiris and Andri Ioannou
31. LNCS 14041, Learning and Collaboration Technologies: Part II, edited by Panayiotis Zaphiris and Andri Ioannou
32. LNCS 14042, Human Aspects of IT for the Aged Population: Part I, edited by Qin Gao and Jia Zhou
33. LNCS 14043, Human Aspects of IT for the Aged Population: Part II, edited by Qin Gao and Jia Zhou
34. LNCS 14044, Adaptive Instructional Systems, edited by Robert A. Sottilare and Jessica Schwarz
35. LNCS 14045, HCI for Cybersecurity, Privacy and Trust, edited by Abbas Moallem
36. LNCS 14046, HCI in Games: Part I, edited by Xiaowen Fang
37. LNCS 14047, HCI in Games: Part II, edited by Xiaowen Fang
38. LNCS 14048, HCI in Mobility, Transport and Automotive Systems: Part I, edited by Heidi Krömker
39. LNCS 14049, HCI in Mobility, Transport and Automotive Systems: Part II, edited by Heidi Krömker
40. LNAI 14050, Artificial Intelligence in HCI: Part I, edited by Helmut Degen and Stavroula Ntoa
41. LNAI 14051, Artificial Intelligence in HCI: Part II, edited by Helmut Degen and Stavroula Ntoa
42. LNCS 14052, Design, Operation and Evaluation of Mobile Communications, edited by Gavriel Salvendy and June Wei
43. CCIS 1832, HCI International 2023 Posters - Part I, edited by Constantine Stephanidis, Margherita Antona, Stavroula Ntoa and Gavriel Salvendy
44. CCIS 1833, HCI International 2023 Posters - Part II, edited by Constantine Stephanidis, Margherita Antona, Stavroula Ntoa and Gavriel Salvendy
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46. CCIS 1835, HCI International 2023 Posters - Part IV, edited by Constantine Stephanidis, Margherita Antona, Stavroula Ntoa and Gavriel Salvendy

47. CCIS 1836, HCI International 2023 Posters - Part V, edited by Constantine Stephanidis, Margherita Antona, Stavroula Ntoa and Gavriel Salvendy

https://2023.hci.international/proceedings

Preface

User experience (UX) refers to a person's thoughts, feelings, and behavior when using interactive systems. UX design becomes fundamentally important for new and emerging mobile, ubiquitous, and omnipresent computer-based contexts. The scope of design, user experience, and usability (DUXU) extends to all aspects of the user's interaction with a product or service, how it is perceived, learned, and used. DUXU also addresses design knowledge, methods, and practices, with a focus on deeply human-centered processes. Usability, usefulness, and appeal are fundamental requirements for effective user-experience design.

The 12th Design, User Experience, and Usability Conference (DUXU 2023), an affiliated conference of the HCI International conference, encouraged papers from professionals, academics, and researchers that report results and cover a broad range of research and development activities on a variety of related topics. Professionals include designers, software engineers, scientists, marketers, business leaders, and practitioners in fields such as AI, architecture, financial and wealth management, game design, graphic design, finance, healthcare, industrial design, mobile, psychology, travel, and vehicles.

This year's submissions covered a wide range of content across the spectrum of design, user-experience, and usability. The latest trends and technologies are represented, as well as contributions from professionals, academics, and researchers across the globe. The breadth of their work is indicated in the following topics covered in the proceedings.

Five volumes of the HCII 2023 proceedings are dedicated to this year's edition of the DUXU Conference:

- Part I addresses topics related to design methods, tools and practices, as well as emotional and persuasive design.
- Part II addresses topics related to design case studies, as well as creativity and design education.
- Part III addresses topics related to evaluation methods and techniques, as well as usability, user experience, and technology acceptance studies.
- Part IV addresses topics related to designing learning experiences, as well as design and user experience of chatbots, conversational agents, and robots.
- Part V addresses topics related to DUXU for cultural heritage, as well as DUXU for health and wellbeing.

The papers in these volumes were included for publication after a minimum of two single–blind reviews from the members of the DUXU Program Board or, in some cases, from Preface members of the Program Boards of other affiliated conferences. We would like to thank all of them for their invaluable contribution, support, and efforts.

July 2023

Aaron Marcus
Elizabeth Rosenzweig
Marcelo M. Soares

12th International Conference on Design, User Experience and Usability (DUXU 2023)

Program Board Chairs: **Aaron Marcus**, *Aaron Marcus and Associates, USA,* **Elizabeth Rosenzweig,** *World Usability Day and Bubble Mountain Consulting, USA*, and **Marcelo M. Soares**, *Southern University of Science and Technology – SUSTech, P.R. China*

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The full list with the Program Board Chairs and the members of the Program Boards of all thematic areas and affiliated conferences of HCII2023 is available online at:

http://www.hci.international/board-members-2023.php

HCI International 2024 Conference

The 26th International Conference on Human-Computer Interaction, HCI International 2024, will be held jointly with the affiliated conferences at the Washington Hilton Hotel, Washington, DC, USA, June 29 – July 4, 2024. It will cover a broad spectrum of themes related to Human-Computer Interaction, including theoretical issues, methods, tools, processes, and case studies in HCI design, as well as novel interaction techniques, interfaces, and applications. The proceedings will be published by Springer. More information will be made available on the conference website: http://2024.hci.international/.

General Chair
Prof. Constantine Stephanidis
University of Crete and ICS-FORTH
Heraklion, Crete, Greece
Email: general_chair@hcii2024.org

https://2024.hci.international/

Contents – Part I

Design Methods, Tools and Practices

Emotional and Persuasive Design

A Design Driven Approach to Innovate System Interfaces: Insights from a University-Industry Collaboration

Stefania Palmieri, Mario Bisson, Riccardo Palomba(✉), Alessandro Ianniello, and Giuseppe Rubino

Politecnico di Milano, 20158 Milan, MI, Italy
{stefania.palmieri,mario.bisson,riccardo.palomba,
alessandro.ianniello}@polimi.it, giuseppe.rubino@polimi.t

Abstract. The user interface influences the objects and subjects on which our actions focus during the application of the artifact. The field that deals with improving the usability of digital interfaces is known as UX/UI Design (User Experience/User Interaction); many organizations or entities are focusing on this field in order to be able to "dialogue" with an increasingly broad target audience. This paper stems from a research carried out within the Interdepartmental Laboratory EDME (Environmental Design Multisensory Experience) which, in collaboration with a company in the home automation sector, sets as a goal the unprecedented design of an indoor video intercom, setting as target both the installer and the end user. The process followed involves research phases for objectivity of choices, and design development phases; as for research, it is divided into desk research, survey and testing activities in which end users are involved for direct acquisition of usage data. The objective of the paper is to demonstrate how a joint University/business research process enables innovation processes both in terms of human relations and in terms of business dimensions for the company, in line with market demands. In this context, the figure of the designer and, more generally, design-driven operations, help define a development model that overlaps and intersects with the technological one, replicable in different business and networking contexts.

Keywords: Search design · Heuristics · Design Thinking · university-industry collaboration · UX/UI Design

1 Introduction

The digital transformation that has been - and is being - experienced with the development of Industry 4.0 has brought many decisive innovations to the ever-changing everyday life, seeking practical and efficient solutions that facilitate the use of new services and/or technological devices. The digital age has encouraged the use of alternative communication platforms that are used as a means of information, but also as a means of bringing the company closer to its customers. The point of contact between any artefact (digital or

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otherwise) and the user is called the 'user interface' and significantly influences the user experience of the service offered. In this sense, it is important to achieve what Thesen and Beringer refer to as 'ease of use', i.e. the combination of several factors such as software/hardware design, instruction and the user's background at the time of dialogue [1]. The subject of usability is, for the reasons stated, a highly topical issue and is understandably the subject of debates and definitions; there are also various standards that define principles, criteria, constraints, etc.: everything converges towards approaches and guidelines that design must take on board, interpret and manage in order to design effectively and on a human scale. For example, the ISO-9241-11 standard [2] defines usability as "the extent to which a product can be used by specific users to achieve specific goals with effectiveness, efficiency and satisfaction in a specific context of use", and in this sense the interface represents the point at which actions are concentrated during the use of an artefact, influencing objects and subjects in a decisive way. This is why, in recent years, the discipline of improving the usability of digital interfaces has developed more and more, this is known as UX/UI Design (User Experience/User Interaction).

Therefore, the user interface plays such a fundamental role that it can convey the very identity of a company, which, in this way, presents itself to the public. Indeed, markets and companies are attributing new value, including cultural value, to these forms of interaction in order to be able to 'dialogue' with an increasingly broader target, speaking an appropriate language that shares values and meanings that are important to the user.

Today, the digital interface is therefore an essential element in the design of a product system, as any artefact is accompanied by a service, normally delivered through digital devices or apps. Therefore, there is an increasing demand for new ways to connect products, users and their surroundings, creating meaningful experiences that bring added value to the service offered. With this in mind, it is essential that actions are simple and immediate, limiting the possibility of error and clearly showing the paths to follow when using the interface. The strategic value of correct interface design is also supported by a survey by McKinsey [3], which shows that a company that focuses on its identity and user touchpoints, implementing design and designing for the human being, will have significantly higher turnover than any other company in the sector. Therefore, it is crucial to consider the digital interface itself a product system, dealing with the complexity of a holistic design that takes into account the market, the environment and, above all, the user, and that offers a meaningful experience by bringing added value during the use of the service/product; market data states that 40% of people who experience a bad UX turn to the competition, and at the same time many products are successful because they offer excellent experiences [4].

Furthermore, the expansion of the sphere of use of information technology places a number of new requirements on the user interface, not only to solve professional problems, but also to meet a person's information, entertainment and communication needs. In addition to standard usability criteria, a modern interface should focus on aesthetic appeal, motivational appeal for the user and thus be based on the holistic, 'user-like' experience. In general, User Experience is the perception and response of a user resulting from the use of a product, system or service [5]. It is a complex process involving analysis and design phases, through loosely formalised procedures such as

surveys, user work monitoring, performance testing and analysis of activity logs, focus groups, interviews [6].

2 Academic Research and Professional Approach: Co-creation and Innovation

The rapid development of technology linked to contexts involving design as a design approach has drawn attention to the cooperation between SMEs and academic institutions. Different approaches and languages open up new avenues for innovation and technology transfer, which undoubtedly increasingly represent one of the levers for competing in global markets and become accessible in a 'network' logic.

Presented here is the design process resulting from a collaboration between university and enterprise, conducted within the Interdepartmental Laboratory EDME (Environmental Design Multisensory Experience) - belonging to the Design Department of the Politecnico di Milano - with Comelit S.p.A. - a private company in the home automation sector. The research, through the design of a new intercom device, lays the foundations for the genesis of a strategic design project, aimed at the definition of guidelines for the review and design of existing and future company products. Starting from the analysis of the company's current ecosystem and catalogue products, certain invariant elements have been defined that can create a family feeling with the aim of giving strength and credibility to new products that will be placed on the market in the near future.

This can be achieved through the academic approach to pre-competitive research and the company's active participation in co-design dynamics, with the aim of creating futuristic scenarios to guide the design process.

This approach complements or follows Basic Research, which is the activity that aims to expand scientific and technical knowledge not immediately linked to industrial or commercial objectives and is usually the preserve of large organisations only. With a view to networking and value co-creation, the university-business relationship becomes a pioneer of new avenues towards innovation and development, and this allows the academic team to create awareness and co-participation on the project's progress, objectivising the choices and highlighting the strategic areas on which to operate. In this way, the company opens up to design issues, adopting innovative methodologies in product making and creating a direct dialogue with its target audience.

This collaboration mechanism allows the company to discover new themes and design cues that can improve its product system and the university to innovate by applying research and analysing the results directly in the professional field [7]: it is a novel approach to networking, which activates new relationships and creates value in a new way for all the partners involved.

The project, developed by the Politecnico team, aims at a sustainable innovation for the company that satisfies the public with the main focus precisely on usability and its meaning. The contribution of design determines from the preliminary stages a strong inclination towards the user's needs through user tests that have been designed ad hoc and carried out in the academic field.

Design, due to its multidisciplinary and transversal nature, is a candidate to play a mediating role, i.e. it becomes the possible strategic connector, the bridge between

companies and academia, with the aim of activating and making research accessible also to those productive realities that would otherwise have structural limits, intrinsic to their small size, to make innovation: design, therefore, as an activator and manager of common networking actions, a driver also of the internationalisation of the local industrial system, is called upon to operate on a very high technological scale.

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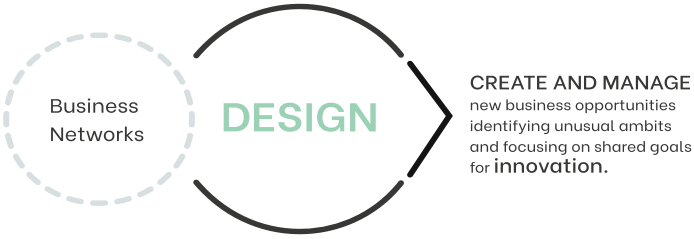

Fig. 1. Design as catalyst for innovation.

3 Design as an Activator of New Multidisciplinary Relations

The research verifies how the figure of the designer and, more generally, design-driven operations, can contribute to defining a development model based on the use of shared technological platforms. Through workshops and co-design activities, design brings innovation into business processes, involving and bringing into dialogue different disciplines, with the aim of maximising the efficiency of the design of strategies or artefacts. The construction of common visions is of paramount importance, seeking to shape innovative usage scenarios capable of significantly modifying different application domains. It is also the designer's task to try to emphasise the transversality and horizontality of his or her discipline: these characteristics make the professional figure adept at managing design complexity and the multidisciplinary integration of knowledge [8].

During design, designers followed two separate objectives that can be distinguished into a long-term and a short-term one. The first focuses on bringing innovation into the company by demonstrating new design processes and identifying new possible users who

had not been considered before; in this way, more direct relationships are established in order to receive valuable feedback for the development of new products and strategies. The second - short-term - objective focuses on the design of a digital interface for one of the company's products: a next-generation video door phone. In this case, the research focused on how best to represent the functions, identifying hierarchies and a language understandable to several types of users. Starting from an analysis of the state of the art, the designers reconstructed the digital structure by reorganising the contents and activities to make the user experience fluid, immediate and comprehensible. The final objective is to synthesise the research (the canons, definitions, trends, etc.) into a graphic and functional prototype, which serves as a guide for subsequent implementation in apps by developers.

4 Design Methodology

From the perspective of designing a technological product, it is relevant to investigate the peculiarities and dynamics of the UX and UI of related and unrelated products. This analytical process makes it possible to frame and at the same time delineate the design perimeter within which to operate. The current and futuristic trends that were highlighted during the research represent a key element in the realisation of a product that responds in a simple and intuitive manner to user needs. To achieve this, it is important to adopt innovative problem-solving processes capable of providing simple and human-friendly solutions, which can be part of the approach called 'Design Thinking'. In this perspective, Design Thinking assumes a relevant role as an analytical and creative process [9] that enables innovative design responses, through a more flexible and inclusive thinking and approach to design. As reported by Gonen [10], it is a human, creative, iterative and practical approach to finding meaningful ideas and solutions with innovative activities; this approach has proven to be an effective strategy for organisational change in many companies.

The project was carried out through four project phases, during which various elements were analysed with the aim of redesigning the system to facilitate its use. At the end of each phase, an official, strategic meeting was organised with the company to discuss advancements and obtain new input and consensus to proceed in an aligned manner; the dialogue was continuous, and interaction took place during all steps, through short, operational meetings with targeted topics and attended by certain elements of the teams according to the pre-established agenda. During the general alignment meetings (at the end of each step), targeted workshops or activities were held in which the team could express their thoughts on the progress of the project, tools of fundamental importance for the success of the final product.

The project methodology mainly followed two research phases, a scenario building phase and a prototyping phase for the final proposal.

More specifically, during the preliminary phase, an internal and external analysis was carried out to understand the company's identity and vision, followed by research on competitors and opportunities in the target market; in addition, the state of the art of the existing product was analysed through a heuristic evaluation and a survey in which users could give feedback useful for the subsequent design. Subsequently, the second phase

focuses on researching present and future market trends, user preferences and interests through an in-depth study of the target audience. This phase made it possible to synthesise user trends and needs into a design scenario, in which the design is hypothesised in one or more specific contexts. Each element that emerged from the previous phases allowed the creation of various design scenarios that led to the design construction phase, in which the research is synthesised and the structure that will support the entire design implementation is built: colours, icons, graphics, language and information architecture. This is followed by the prototyping of the interface and the formal proposal of the system produced (Fig. 2).

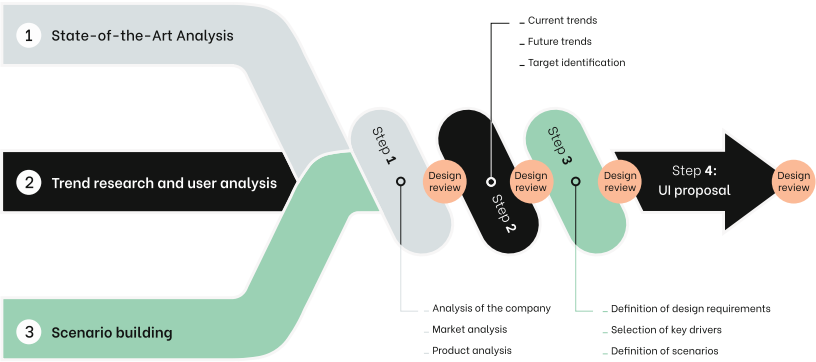

Fig. 2. Summary of research methodology.

5 Step 1: Analysis of the State of the Art

During the first phase, it was necessary for the designer to understand who his interlocutor (customer) was. With this in mind, the research aimed to define the company's brand identity, the market it covers and how it is positioned in relation to its competitors, and finally, the analysis of the product portfolio. During the brand identity analysis, the researchers' focus is on how the company addresses the market, what its values are and how it communicates them, analysing the tone of voice and proximity to the user. At this stage, it was appropriate to analyse reports or surveys previously carried out by the company itself, or to organise new ones. However, the focus is not only outward-looking, in fact an attempt is made to understand the internal hierarchical structures and the degree of employee satisfaction - starting from the dialogue with the team with which one interfaces during the project - with the aim of defining the most appropriate approach to align with the corporate image.

Once the corporate identity has been explored and mapped, we move on to the analysis of the product portfolio, starting with a division into generic clusters that group the different categories of products presented on the market by the company. On the basis of the differentiation of the offer, it is decided whether to analyse the entire company portfolio or to verticalise on a specific type of product. In this case, the focus was on video

door phones, analysing their shape, the type of interaction with the user, the perceived degree of technology and the levels of feedback returned by the different interfaces. This resulted in 6 different categories of video door phones, from the simplest and cheapest to the most complex (in terms of technology) and expensive.

The research team then studied the target market based on geographical positioning, identifying the best-selling products, the areas of greatest interest and the distribution and sales channels. At this stage, the main competitors were identified and compared against objectively determined parameters.

The parameters that were identified for the research are as follows:

- Catalogue size: the number of video door phones in the catalogue;
- Morphological diversification: the aesthetic and morphological variety of the company's offer of video door phones (e.g. with or without handset, with or without buttons, …);
- Global coverage: the number of locations located globally;
- Offer differentiation: the company's variety of offerings (e.g. video door phones, security systems, home automation, …);
- Service oriented: the presence of the service side in the company's DNA;
- Training courses: the quantity of offers for training courses and certificates as a professional figure.

The purpose of the analysis is to position the company among its competitors in one or more matrices that clearly identify more saturated market segments and less explored segments, which potentially represent possible directions in which the company should turn its attention. These 'less crowded' areas are referred to as the 'Blue Ocean' [11] and denote a slice of the market where demand is created rather than fought for and there is ample opportunity for growth that is both profitable and rapid. Competition is irrelevant because the rules of the game are waiting to be established (Fig. 3).

The analysis of the brand identity, the synthesis of the product portfolio and the identification of the target market are fundamental steps in order to best direct the design process. This phase is also very important for the company, which is analysed by a group of external professionals and, depending on the feedback, can understand whether its image and market performance are in line with its declared values and mission.

5.1 Heuristic Evaluation Test

Once this first part has been defined, phase 01 continues with the in-depth analysis of the product for which the interface is to be redesigned: the video door phone. With this in mind, the information architecture is initially studied, going on to create a diagram that makes explicit, in a clear and complete manner, the levels of complexity of the flow and the groupings of the main functions. In the case presented, the information architecture was considered very complex and difficult to navigate by an end user; for this reason, a usability test (Heuristic evaluation) was organised that could - as objectively as possible - define the system's significant criticalities.

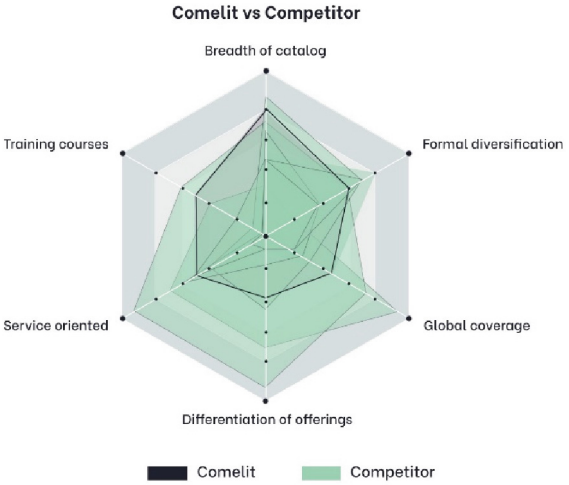

Fig. 3. Summary of the research methodology The radar graph shows the possibility of improving the offer from a service point of view, implementing a service-oriented approach and differentiating the offer by creating proposals for a family of products, different but in communication with each other.

The Heuristic evaluation is an in-depth assessment of the user interface of a product, conducted by a team of evaluators, which is based on the 10 principles of Nielsen-Molich [12].

1. Visibility of the system state;
2. Correspondence between the system and the real world;
3. User control and freedom;
4. Consistency and standards;
5. Error prevention;
6. Acknowledgement rather than recall;
7. Flexibility and efficiency of use;
8. Aesthetics and minimalist design;
9. Helping users recognise, diagnose and recover from errors;
10. Help and documentation.

Its purpose is to detect usability problems and identify ways to solve them. It is characterised by an initial process in which the expert evaluator experiences, in first person, the experience of using the product, and then subsequently detaches himself from subjective judgement in order to assimilate the experience as objectively as possible; he then compares the 10 Nielsen-Molich principles with his own experience of interaction and draws qualitative tasks from them that he will subsequently submit to the users participating in the test.

In the case presented, the Tasks generated by this process were classified into four groups:

1. Basic functionality: Task to answer the video intercom and open the door. It is the same for all, which allows more data to be obtained on the basic use of the product.

2. Keypad functionality: secondary activities to automatically manage certain everyday situations (e.g. automatic opening, sending notifications, etc.). It focuses on the recognition of icons in the keyboard in relation to their functionality.
3. Menu functionality: activities that can be performed by navigating the system at a low level.
4. Setup menu functionality: activities that can be set by navigating into deeper levels of the menu, managing different functions in the device settings. It is structured with three questions of progressive difficulty that assess the parameters of "Correspondence between the system and the real world" and "Flexibility & Efficiency".

The Tasks are, however, a part of the survey that was structured in 3 phases, in which 26 testers participated, including men and women of different ages (late Millennials and Generation Zeta) and with different qualifications (undergraduate or graduate in Product Design, Interior Design, Interaction Design, Design Engineering, Design Integrated). The profile chosen for this analysis is of young designers who are predisposed and trained in curiosity, creativity and attention to detail. This means that the activities performed by them during the test, guided by questions posed ad hoc, are extremely significant and bearers of important considerations for the possible future development of the analysed system (Fig. 4).

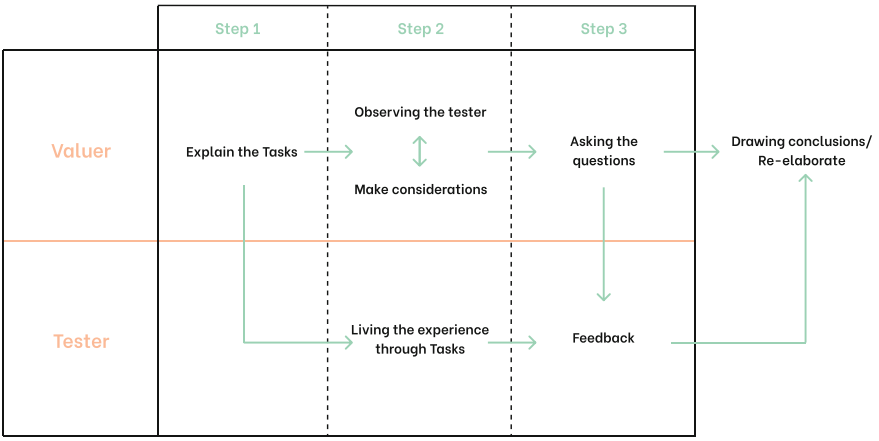

Fig. 4. Methodology followed during the survey.

Initially, the structure and timing of the subsequent phases were clarified; in the second phase, the testers were divided into 4 groups, each with 4 tasks to be carried out in a maximum of 4 min (1 min. Per task), the time taken to recognise and activate the buttons of the respective tasks was timed and any errors in use on the part of the tester were recorded; the last phase subjects the tester to a questionnaire structured in two blocks of questions: 4 closed questions assessed according to the Likert Scale [13] and 3 open-ended questions.

The results of the tasks were relatively negative, with a large percentage of users failing to complete the setup menu tasks, and many having difficulty with even the simplest tasks of the first two (Fig. 5).

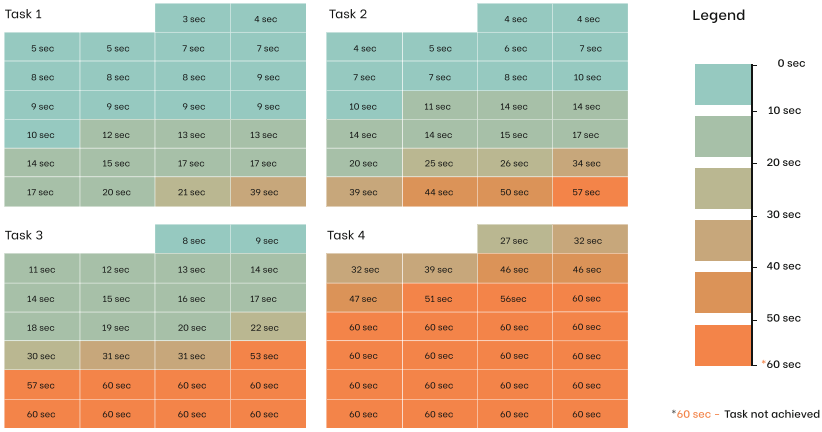

Fig. 5. Mapping the variable 'time' for task completion.

As for the results of the survey, they were summarised in a table showing the main issues in which users found difficulties. By cross-referencing the open and closed answers, a score was given relating to the number of people who mentioned one or more functions in which there were difficulties (Fig. 6).

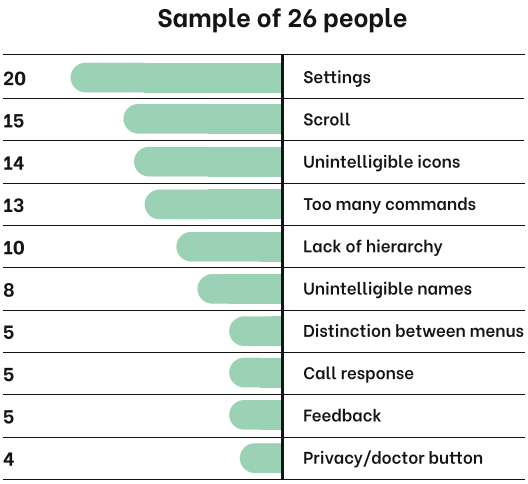

Fig. 6. Summary of the main items in which the testers found difficulties during the survey (from the most complicated to the least problematic).

The survey is therefore a powerful tool for verification and exploration, supporting an applied research phase. The results must always be understood as qualitative and not quantitative and were then processed to activate a design process around the criticalities detected.

This activity led to an understanding of the current state of the digital service expressed by the video intercom, and, by defining the degree of complexity that characterises it, to identify the areas susceptible to improvement.

The following emerged from the tests (Fig. 7):

#1: Visibility of system status	The system, with regard to commands, is sufficient for the main ones (door opener and phonic), while for secondary commands the situation becomes more complicated by reducing the visibility value of system status;
#2: Match between system and the real world	The perceptual components–the words used, the icons the colors, and the feedback–are poorly correlated with the real world except with regard to the iconic components of the main commands;
#3: User control and freedom	The system does not allow much freedom to the end user since the interface is not based on an intuitive mode of paths but on a mode that must be memorized;
#4: Consistency and standards	The system is consistent with a current trend resting on similar technologies and interfaces (small and large appliances, automotive, etc.);
#5: Error prevention	There are no elements that would hint at possible error (e.g., color change in case of misspelling, which would lead to avoidance of a sense of disorientation on the part of the user);
#6: Recognition rather than recall	The level of memorization required for user operation of the interface remains high;
#7: Flexibility and efficiency of use	Some functions appear to have too many diversification options so much so as to confuse the user;
#8: Aesthetic and minimalist design	Morphologically well-structured, but excessively minimalist: consequently unrecognizable and lacking semantic identity (innovation of meaning);
#9: Help users recognize, diagnose, and recover from errors	Error indications are detected but no solutions are suggested;
#10: Help and documentation	Both digital and paper aids are good support for installers, dedicated end-user aids are basically paper-based and structured for technicians.

Fig. 7. Survey results compared with the 10 Nielsen-Molich principles.

6 Step 2: Trend Research and User Analysis

The data collected during the previous phases made it possible to better delineate which factors and processes are inherent in the use of devices with interfaces. With this in mind, a search was conducted for interfaces belonging to different product ranges on the market.

In order to best categorise the product characteristics, six polarities were defined with the aim of defining the most common elements of digital interfaces.

- Information architecture [14]: Depth and complexity of the system. A clear AI facilitates the user in the usability of the interface. A high score expresses greater complexity and depth of the system.
- Hick's Law [15]: States that if there is an overabundance of choices, the user will take longer to reach a decision. The ideal number of options for a screen is a maximum of 6 choices. A high score corresponds to a good visual organisation of the interface.

- Von Restorff effect [16]: Claims that graphically highlighting the main buttons provides immediate distinction. In an interface, hierarchy is fundamental for the user to identify the actions to be performed. A high score indicates the presence of highlighting of the main functions.
- Words - Amount of words used in the main screen of the interface. A high score indicates an overabundance of words in the interface home screen.
- Pictograms - Amount of pictograms used in the main screen of the interface. A high score indicates an overabundance of pictograms on the interface home screen.
- Feedback: Used by the system to engage or notify the user of a certain action. It can be characterised by sound, visual or tactile outputs. A high score indicates the presence and effectiveness of feedback received by the user during interaction.

Cross-referencing the various products with the analytical parameters defined above showed that most interfaces rely on the use of a well-defined, simple and intuitive graphical and structural design of the system for the user. Indeed, as described above, the system must have a high level of recognisability and clarity of use. However, in many cases this ease is only effective for certain user groups, which makes the system produced unsuitable for a wider public.

In this context, the analysis of current and future trends affecting these product categories becomes relevant. The analytical phase makes it possible to identify the factors that make the product avant-garde and at the same time usable by several categories of users.

The role of design, after all, is to allow products and services to be used by the widest possible range of subjects, promoting design for the real individual, which is inclusive and holistic, enhancing the specificities of everyone and involving human diversity in the design process. With this in mind, five user categories were analysed from different perspectives. During the analytical phase of generational profiling, the following audience groups were identified:

The Silent Generation consists of people born between 1925 and 1945. This category of users approached digital in order to stimulate social relations, not to feel lonely, and to get closer to the life habits of their children and grandchildren in order to 'speak' their language. The Silent Generation is not a representative sample among web users, yet it should be considered in communication actions and online campaigns, especially for certain markets of their interest…

The Baby Boomer Generation consists of those born between 1946 and 1964. The Boom Generation is almost completely absent from social plus, where instead the presence of Millennials is exploding. This category of users is very interested in brands and advertising messages, so it is a generation that should absolutely be considered in web marketing strategies, also because it is the one with the highest purchasing power compared to the others.

Generation X consists of people born between 1965 and 1979.

A study by Nielsen showed that Generation X people spend more time than others on social and other digital devices.

Generation Y consists of people born between 1980 and 1994.

Millennials love social media and use them to learn about current trends. They are people who are familiar with the mechanisms of communication and promotions, so

they pay special attention to the message, only if it is truly appealing. More than half of Millennials use smartphones to connect online, so they pay more attention than others to short, creative communications. People of this generation are used to using more than one means of communication at a time. Therefore, it is necessary to curate communication with respect to their preferences.

Generation Z consists of people born between 1995 and 2012.

They were born among smartphones, tablets and touch screens, but unlike the 'millennials', who joined later, members of Generation Z discovered the product instructions without anyone teaching them. It is hard to imagine, then, that any daily action of these very young people does not pass through technology.

Once the characteristics and needs of the users were defined, the world and continental population density divided by user category was analysed. This step made it possible to highlight which markets can be exploited in terms of audience, opening up new project scenarios.

The previous steps provided a clear picture of the geographic areas and population density related to the five user groups. With this in mind, research was carried out with the aim of defining and graphically translating the relationship between generations and digital devices.

This process, on the one hand, delineated the user categories to which the produced system should be addressed, with the aim of identifying and categorising the target group for an inclusive and accessible design by a certain variety of users, and on the other hand, facilitated the process of generating design scenarios (Fig. 8).

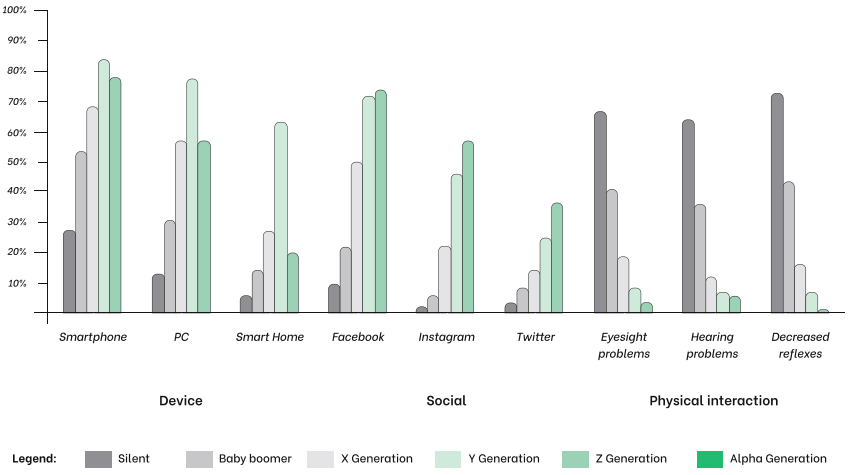

Fig. 8. Percentage of people, by generational cluster, with respect to a given input.

7 Step 3: Scenario Building and User Analysis

Scenario building is a fundamental step in the design process. It is a powerful tool for exploration, synthesis and communication, particularly useful in the phase preceding interface development and implementation.

Scenario building is used by organisations and institutions to help understand futures, expand imagination and raise awareness of changes in the business environment. The scenario planning process can help manage uncertainties in an increasingly dynamic environment, especially if they are perceived as plausible [17].

This phase therefore represents a key moment for the project: given the relevant case studies, trends and users, design requirements are defined that will constitute the project drivers and that may, depending on the situation and the different scenarios, assume different importance, falling into different hierarchies of valorisation.

In the case presented, the design requirements were categorised by semantic affinity into four drivers: identity, user, context and feedback.

- Identity: this driver refers to the analogue & digital identity that characterises the interface and indicates the recognisability of the interface with respect to a 'family' of products.
- User: this driver refers to the ease of use of the interface with respect to the user base, defining an interface adaptable to the various generations of users.
- Context: this driver refers to the context of use of the video door phone and reflects a greater adaptation to the characteristics of various contexts of use.
- Feedback: This driver refers to the feedback levels of the system (sight, touch, hearing) (Fig. 9).

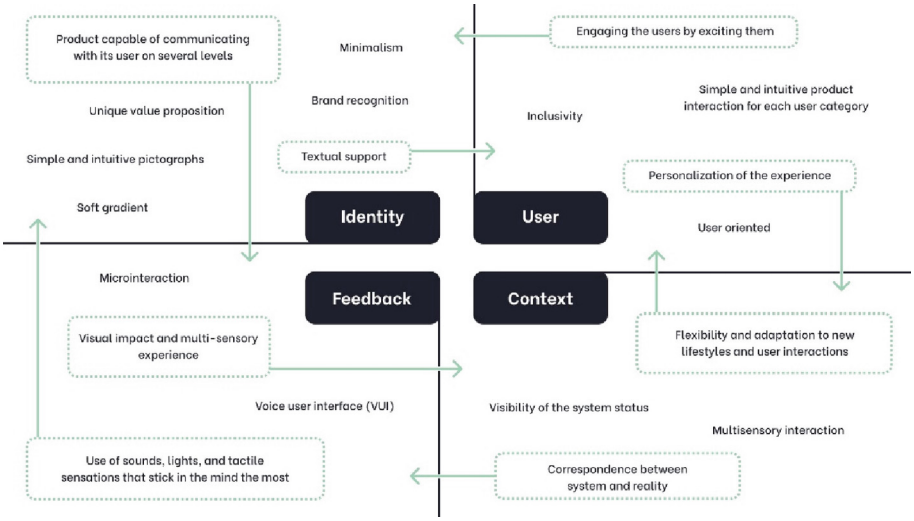

Fig. 9. Clusters of requirements grouped in relation to the reference driver (arrows show requirements common to several drivers).

These drivers represent real polarities towards which to orient the project. By taking certain requirements into consideration, rather than others, one can orient the project towards drastically different solutions, directing research towards objectives recognised by the market and in line with the values of the reference company.

With regard to the company in question, two drastically opposite scenarios were identified on which to operate: one of a disruptive nature, the other of a moderate nature, in line with the case studies on the market identified as best practice.

The first scenario has been called 'Iconic' and is based on the search for new aesthetic and functional languages that create value and relations with younger and digitally connected user segments. The scenario envisages a recognisable and iconic interface, characterised by a high degree of flexibility and adaptation to new lifestyles. The customised interaction adapts to the characteristics of the context of use, favouring a quick and easy use that reflects the user's needs.

The second scenario is called 'Smart' and aims at an interface belonging to a brand-related product family. Immediate, agile and functional solutions are sought which favour simple use and are suitable for a wide range of users. Interaction takes place through clear, multisensory feedback that, regardless of context, precisely communicates the system's state of activity.

The scenarios have been compared on a matrix in which the drivers act as polarities, the comparison sees the Iconic scenario, more disruptive, oriented towards context and identity drivers, in favour of greater personalisation and a more empathetic impact towards a user accustomed to the use of digital devices; the Smart scenario, on the other hand, leans towards the user, feedback and identity drivers, defining a simpler interface, suitable for a broad target, but which retains characteristics that stand out from the market, representing the company through several products in dialogue with each other (Fig. 10).

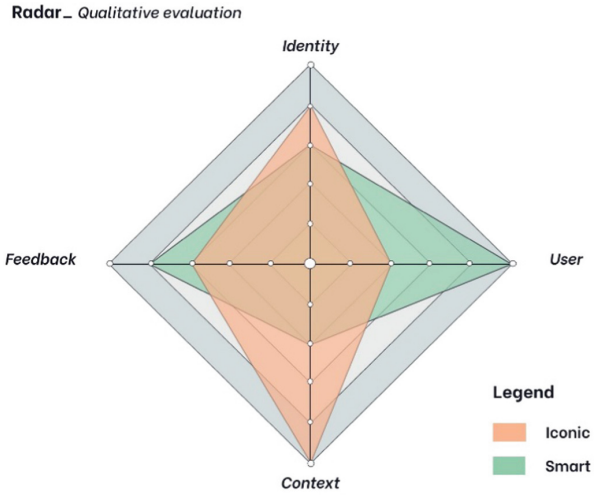

Fig. 10. Design scenarios versus drivers.

In this specific case, the company, through a workshop and dialogue with the design team, was able to choose the scenario that best represented the company's core business with respect to its positioning in the video door entry system market. The Smart scenario turned out to be best suited to the company's needs.

8 Step 4: UI Proposal

The insights that emerged from the previous phases, following a further analytical and scenario synthesis phase, guided the progressive concretisation of the UI, first theoretical and then practical.

The generation of a new interface was marked by two steps, during which the information architecture and the aesthetic-functional part of the system were defined.

The information architecture was divided into four macro-areas, each with a depth of two levels. The various levels have a number of slots following Hick's Law theory, with a maximum of six functions per subject area. This structure allows the user to be in screens that are not overloaded with information, making it easier to read and understand the system. In addition, functions have been introduced that allow the user to customise the interface in a non-invasive manner; this choice is determined by the fact that excessive customisation freedom risks distorting the functional and aesthetic design of the product, while undermining its recognisability.

With this in mind, the system's pictograms were designed, focusing on brand identity and visual familiarity. Starting from the icons of the previous interface, work was carried out to redesign new stylistic elements, based on recognised libraries. They were then reworked and characterised according to their specific function, to represent the meaning and reflect the values of the company.

Once the stylistic elements were realised, various graphic proposals were designed to communicate in a simple and intuitive way with the public. These elements pick up on the company's colours, shapes and graphic imprint so as to create a common thread between the product and brand identity.

9 Conclusions

The results obtained by Comelit S.p.A. thanks to this model of collaboration with the University are mainly two:

- The opening of a new channel to access research aimed at designing new possible business scenarios.
- The design of new products, with a level of attention to human-centred issues not yet applied in its core business (greater attention to the customer, understood as any figure dealing with the product during its entire life cycle)

The cooperation model is replicable for all SMEs, easily adaptable to individual needs, to create a common ground for growth and contamination, a strategic key to compete and innovate.

The design process, recounted here in its genesis and application, concluded with the delivery of a navigable prototype complete with all the main screens. This was built

using special software that facilitates the implementation work by the programmers, defining the different components that represent the modular basis for the buttons, icons and lettering of the interface. The prototype is the result of a series of meetings (meetings, workshops) that, through shared choices, steered the project towards solutions in line with the corporate identity and market objectives.

In this context, design plays a key role, as a strategic lever and activator of relationships that bring new values and meanings.

A significant, and strategically relevant, response is to set up an in-house design centre that can play the role first and foremost of all-round technology scouting, to bring constant innovation to processes and products, creating continuity between them, capable of dialoguing with different partners to amplify knowledge.

The reported case reflects precisely on this: on the competitive advantages of an academic approach typical of the design discipline, which is research-oriented and applies a collaborative co-design process to strengthen internal and external (with users and the market) relational dynamics.

Moreover, development innovation (and not just incremental innovation) is the daily commitment of thousands of small and medium-sized enterprises, even if often in a non-continuous manner due to size or resource constraints. And it is from here that we must start if we want to promote a meeting between the productive fabric and innovation centres that is a multiplier of productive initiatives provided that companies recognise the real value for improving and expanding business. At the same time, researchers, while maintaining scientific autonomy, need to find a favourable ground favourable terrain to transform ideas into innovative industrial projects and transmit cultural and technological approaches to industry, which is often too tied to practices that come from afar (Fig. 11).

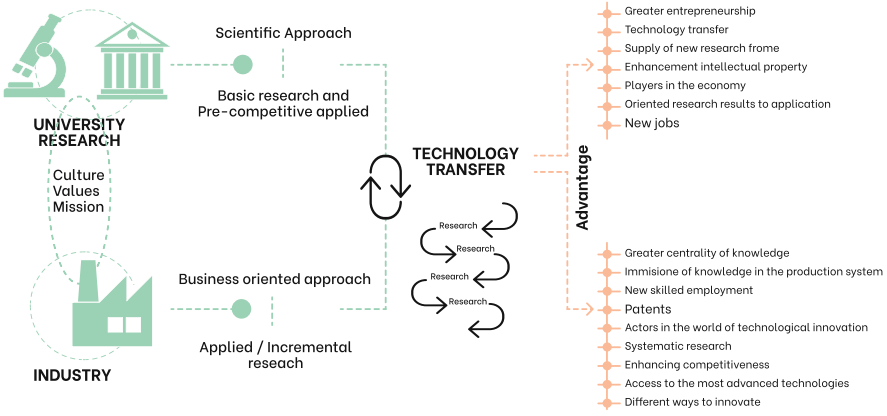

Fig. 11. University-business cooperation for innovation

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