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Technology-led evolution of interior space: Interiors becoming products

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Abstract
Information and Communication Technologies (ICTs) were hosted by industrial products since their emergence in the 1980s. They entered daily life through products – in the shape of black boxes – and changed habits, ways of executing tasks, and dynamics of interaction with each other and our surroundings. ICTs offered a revolutionary domain, the digital world, and used physical and digital representations and tools to manipulate this world. As offerings of the digital increased, human-computer interaction and its design gained importance, User Interfaces emerged to meet human diversity and dynamicity. Today ICTs' hosts are shifting from products to spaces. In this study, we investigated the relation between ICTs, products, and spaces to understand the needs of space as ICT hosts. Sensory diversity in user interfaces increased, physical restraints of hosts decreased, and new more adaptive technologies such as artificial intelligences and augmented reality emerged. The evolution of user interfaces indicates the goal is to implement natural interaction, placing the user at the centre and mimicking the way humans interact with the physical world. While both architecture and product design are user-oriented, product designers practised more on implementing ICTs to hosts as the initial hosts were products. Since ICTs are becoming embedded into spaces, interiority is changing, built environments will consist of conventional building elements, ICTs, and user interfaces. As the host is shifting, interiors are becoming a part of communications systems that needs a transdisciplinary approach to design.

Keywords
Architecture, Human-computer interaction, Interaction design, Interior architecture, Product design.

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1. Introduction

In order to train professionals who caInformation and Communication Technologies (ICTs) brought our lives a non-physical dimension – the digital world – which offers new ways of executing tasks without the limitation of the physical world. This non-physical dimension altered daily life and human-product-space relationships with new artificial intelligence and landscapes. Products such as computers, mobiles, etc. emerged, and ICTs become embedded in existing products such as cars and household products.

ICT embedded products dominated the physical world as their offerings were far greater than their disadvantages such as lacking sensory diversity, complexity, etc. Lack of diversity in senses, thus the whole experience, is caused as a result of depending mainly on visual and audial channels. Contemporary life takes visual as the primary of the senses, but humans perceive the world and learn through their whole body (Pallasmaa, 2005; Kirsh, 2013). Initial products of ICTs were also complex to use, depending on users' cognitive abilities such as memorizing, making it harder for users to adopt. The domination of technology and lack of human-centred approaches are criticised with claims that technology should serve human values and needs, by both architects, product designers, and computer scientists. Human-Computer Interaction (HCI) gained importance and the field of Interaction Design emerged. Interaction Design deals with ways of shaping everyday life and tasks with the help of digital artefacts (Smith, 2007). To develop better interaction, User Interfaces (UIs) emerged and the evolution of these UIs – both in the means of digital and physical representation – indicates that the goal of Human-Computer Interaction is to achieve a natural interaction between the physical and the digital worlds focusing on user experience. Core philosophies of architecture, product design, and ICTs are very similar, as they all aim to enrich human life. They offer, define, alter habits, tools, perspectives, habitats for living. They are integrating into interiors and offer new tools for interiority. Architecture, as a system approach, holds valuable knowledge about natural interaction between humans and their surroundings (Pask, 1969; Wright, 1953; Le Corbusier, 1923/2013; Glanville, 2009; Mallgrave, 2013).

Developments in technology affect architecture and product design profoundly. Economical, technological, and industrial changes reflect into the dynamics of design; the industrial revolution and second machine age affected society, therefore design (Hight & Perry, 2006). With ICTs, the communication age began, and similar to their predecessors, ICTs altered society and daily life in several aspects, including communication, new business models, and boundary-free. They also offered new mediums to interact, communicate and create, and these mediums became essential to today's living. As stated earlier while they enhanced life in many ways, they also weakened the natural interaction with the world. Though, as new ICTs and supportive technologies develop, current disadvantages such as lack of sensory diversity, physical dominance of technology, static products, and spaces will be eliminated.

ICTs brought several challenges, drawbacks, and limitations on issues like perception, representation both physically and digitally along with new opportunities for interaction. When the increasing effect of these technologies is taken into consideration designing the digital domain, its interface and tools gain importance. While ICTs' relation and effect on built environment and products are discussed individually in the literature, their effect of giving interior spaces product-like features without losing their architectural identity is mostly overlooked. Regarding to this, we took a transdisciplinary approach to understand theoretical connections between architecture, product design, and interaction design along with the evolution of ICTs, UIs as their digital and host products as their physical representations. Also, we hold a holistic perspective on built environment, without separating the interior and exterior, without addressing the applied differences in the professions of architecture and interior architecture.

2. Information and communication technologies

ICTs first initiated in the 1960s and Human-Computer Interaction research of the time was mainly about technological and technical aspects of executing tasks. Initial research on HCI began at universities and labs funded by major institutes such as NASA, and there is a 20 years gap between university and commercial product research (Myers, 1998). This gap is a consequence of the initial HCI research's goals, as it was to create digital assets to execute specific tasks.

The roots of ICTs rely on Cybernetics, a science field initiated in the post Second World War (SWW) era to investigate data flow and management systems, which later influenced fields like information gathering, economics, and computer science (Akman, 1977; Bayazıt, 2004). The whole process of data production along with data exchange and creating a common understanding are objects of this science. Earth, filled with unlimited data, consists of and depends on information and communication systems (Wiener, 1958/1973). Information and communication systems differ from each other in the process. Information systems are linear one-way processes with actors who are either recipients or sources. Data flows from source to recipient, and the interpretation process of the recipient is not taken into account. For example, fruit on a tree might be poisonous and its bright colouring might be the data that it spreads, though without proper knowledge the recipient can't translate this data. For information systems, time has a very limited effect. On the contrary, communication systems depend on time more, and they are circular and iterative two-way processes with actors who are both the recipient and the source to create a mutual understanding. Typical human-to-human interaction is an example of these systems and communication machines have similar processes to living beings' interactions (Wiener, 1958/1973). They sense, interpret data, and respond to different situations in an iterative motion.

Regarding creating a communication system with ICTs, 'Ubiquitous Computing' vision emerged after the ICTs become more integrated into daily life and dominated interior spaces with static computers in the 1990s. This vision offered to embed – and hide – computers into interiors and products which were present for centuries (Weiser, 1991). First generations of ICTs lack the ability of intuitive and comprehensive thinking, causing disintegration of users (Haque, 2007). Ubiquitous computing focuses on the actual complete interaction between users and computers to overcome this obstacle.

2.1. The virtual mind and new landscapes

Ubiquitous computing and the need for assistive technology to navigate through the digital world resulted in research on creating a virtual mind. A mind that takes over some technical processes that require thinking and memorizing such as coding and calculating from users. Initial research was to program these thinking processes into predefined situations but a system of predefined questions and answers cannot create novel responses and have common sense, and count as 'smart' (Haque, 2007; Kaku, 2011/2015). The concept of a true 'smart' asset is around since the 1950s, researchers claimed repeatedly that "in a couple of years" an artificial intelligence will emerge (Bostrom, 2014). Through seventy years there were many attempts to create an artificial intelligence (AI) – superintelligence – similar to the human mind. While superintelligence is still a future concept, we have AIs embedded in many areas of daily life doing tasks such as speech recognition, medical assistants, industrial robots, personal assistant AIs, etc (Bostrom, 2014).

Recent developments in AIs resulted in new intelligences in the digital world such as Ambient Intelligence (AmI) using Internet of Things (IoT), Machine-to-Machine (M2) along with other supporting technologies. Even though existing AIs are mostly task-oriented, they are hosted by many products such as mobile phones, tablets, etc. While the hosts of these AIs are commonly commercial products, developments in sensors, cameras, and actuators make it possible to implement them into spaces.

A digital environment should be able to assist users subtly and sensitively, understanding the needs of privacy, help, assistance, etc. while they perform tasks (Augusto, 2010). AmI and AI are still under development as these kinds of understanding and interaction require social intelligence. Though there is still a need for improvement in these technologies, with the help of IoT, it became possible to alter soft mediums – such as lighting, auditory, visual mediums – in interiors without actually being there.

Concepts of Virtual Reality (VR) and Augmented Reality (AR) emerged as an answer to determine the landscape of ICTs. VR offers an immersive experience for users, blocking the real environment completely to show a synthetic environment. On the other hand, AR offers a mix of realities, using markers, cameras, etc. to implement digital artefacts in the physical world (van Arnhem et al., 2018). Though they are both about creating a diversion from the physical world, the simulation types they offer are distant. In AR users both experience the virtual asset and physical surroundings simultaneously, though, in VR, experience is built upon the limited sensory channels (van Arnhem et al., 2018). All these technologies offer alternative landscapes to place ICTs, creating new channels to impact daily life.

2.2. Between the human and the computer: User interfaces

User interfaces are the connection between digital and physical worlds, and developments in supportive technologies in both domains affected their evolution. User interfaces can be examined under these groups: Command User Interface (CUI), Graphical User Interface (GUI), Tangible User Interface (TUI), and Next-Generation User Interfaces (Next Gen.UI).

First digital computers used command lines, without any operating systems. The visual representation of the interface was lists of documents, programs, etc. on black screens, and users needed to know specific codes to navigate through the system, execute tasks, and run programs. CUIs load users a cognitive load on memorizing all the codes and their purposes. Operating systems with overlapping windows emerged to overcome these obstacles (Myers, 1998).

Graphical User Interfaces (GUIs) used operating systems with windows, icons, menus, and pointers (WIMPs), hid the technical process, and visualized tasks. GUIs' innovation over CUIs was bringing graphical representation, creating a more direct 'see, point, click' interaction using WIMPs (Ishii, 2008a). Graphical User Interfaces made it easier to operate computers but they had their limitations of using screens and keyboards and interacting mainly on visual and audial channels. These limitations are criticised widely as the natural interaction between human-product-environment requires a whole-body interaction and GUI interaction is distant from it (Weiser, 1991; Wellner et al., 1993; Ishii & Ullmer, 1997; van Dam, 2000).

Tangible User Interfaces (TUIs) emerged to overcome GUIs' dependence on visual and audial channels. One of the earlier examples of TUIs is the Graspable User Interface from the mid-90s, which uses physical wooden objects with assigned attributes to manipulate digital objects. Multisensory perception plays a bigger role in encompassing 'realness/sureness', and using peripheral senses to perceive and manipulate the digital with physical is the key concept of TUIs (Ishii, 2008b; Shaer & Hornecker, 2010). A child's abacus is a perfect example of TUIs as its capabilities can be easily understood without a written description because of its simplicity (Ishii, 2008a). Also, it has both intangible and tangible assets, users have the flexibility to assign beads and rods a number according to their need and calculate. This flexibility allows users to calculate a broad selection of numeric quantities with its limited physical quantity. In TUIs, physical objects might represent digital assets rather than intangible and physically non-existent graphics. For example, game consoles such as Nintendo, Xbox, and Playstation use TUIs on different levels. While Xbox Kinect offers an interactive platform that can track movement without any tangible tool, Nintendo Wii and Playstation Move offer platforms to track movement with the help of tangible tools such as boards or sticks. In all these platforms, users' actions are tracked and processed with the help of an artificial intelligence (AI) to evaluate their performance in the games.

Physical restrictions such as the rigidity of physical objects are creating a contrast with limitless digital fluidity (Lakatos & Ishii, 2012). Developments in related fields such as materials, biology, nanotechnology, and programming decreased this rigidity, and the next generations of UIs offer more flexibility. Materials that can change form and appearance in a dynamic way as digital pixels are offered as a way to overcome mentioned obstacles (Coelho & Zigelbaum, 2011; Lakatos & Ishii, 2012). One of the limited examples of such an interface is MIT Tangible Media Group's LineFORM (URL-1), which uses little servo motors to change the shape of a line-formed product to answer different needs. It can act as a phone, create a surface, fitness tool, or a lamp with some extensions. Another example, Second Skin (URL-2), uses living organisms to interact with the human body. Second Skin is an article of clothing for athletes, dancers, etc. This clothing has little patches embedded with hydrophobic bacteria through nanotubes, which helps with ventilation when the user sweats. Second Skin project expresses a subtle interaction similar to real-life experiences by using living organisms.

Another promising work is Digital Nature Group's Fairy Lights in Femtosecond (URL-3) project, as it offers a non-material but touchable interface. Researchers investigated the nature of the touch sense and created a mid-air hologram – a half digital half physical asset – that burns the skin so slightly that it does not hurt while mimicking the sense of touch.

3. Hosts of ICTs: Products and spaces

Initial ICTs were hosted by products and as a result of the physical and digital limitations of the time, they entered our life as black boxes (Marzano, 2005). Through time both the digital world's offerings get diverse and the physical world's limitations in production, material, sensing, monitoring, and computing assets decreased. Therefore, it became possible to have varying ICT hosts. Philips Design's High Design concept focuses on the past, present, and future of life through a sketch of a living room, envisioning a future living similar to the past but with the capability to connect the digital world through ICT embedded products instead of the dominance of black boxes (Marzano, 2005). Wearable products such as watches are a good example of this shift, as ICTs are used in these existing products in an enhancing way by combining centuries-long non-digital interaction and new digital interactions. HCI should shift its focus from techno-centric to human-centric, in order to reach a natural interaction between humans and technology, as it is not logical to further develop a specific technology without considering the needs, wants, and capabilities of the user (Mau et al., 2004). Though the dynamicity of humans is not yet met with digital dynamicity, technological capabilities change faster than human capabilities. ICTs become varied, digital artefacts or the physical presence require different features. Since their emergence, products born as a result of ICTs such as computers and mobiles changed both physically and digitally as they become smaller and portable. Existing products such as watches, kitchen appliances, and cars become embedded with ICTs. In between these existing products automobiles stand out as a good example of ICTs' relevance to both products and spaces.

3.1. From ICT dominant products to products with ICTs: The example of the automobile

Automobiles are special industrial products as they offer interiority. Both exterior and interior design of a car is involved in the users' experience. Therefore, ICTs' inclusion in automobiles holds important clues about their effects on both product level and space level. ICTs are embedded in cars in many ways including technical, entertainment, and information systems. Though many of these technologies are embedded into the vehicles' technical systems such as Anti-Lock Braking System (ABS) or Electronic Stability Program (ESP) to make driving safer, these kinds of ICTs are not creating a rich interaction with the user. When user-related ICTs are taken into account, one of the earliest embedded ICTs is the car radio system. The first radio, as one of the main mass information systems along with televisions, dates back to the 1900s, while the first radio-mounted cars emerged in the 1930s. First versions of car radio systems consisted of a radio with a small turntable (Brandt, 2013). Later with the developing technologies such as cassettes, CDs, and Mp3s, car radio systems began to evolve with built-in cassette players, CD players, USB connections, etc. Music – an intangible medium – became portable with ICTs, and changed the perception of automobiles' interior space by turning interiors into specialized private space without losing its public space features (Bull, 2004).

Similar to computers and mobile phones radio systems become embedded in road computers with screens. Along with radio systems, new features such as navigation, air conditioning settings, hands-free phone/application connections, and driving-related settings become a part of these screens. 'Center Fascia' – which is the middle part of the Instrument Panel – evolved around road computers' screens (Kim & Han, 2014). Considering driving safety issues, interacting with a screen during the drive can be counted as a distraction. Designers, engineers, and researchers try to embed AR technology in cars to eliminate this distraction. Head-Up displays emerged as a result of these efforts, making it possible to get informed about navigation or driving information without getting driver's gaze off the road. Artificial Intelligence also influenced the car environment by adding self-driving, self-parking, line tracking, fatigue detection systems. Several car manufacturers such as Tesla and Volvo are investing in complete autonomous cars. If ethical and technical issues are solved and these autonomous cars enter the market, they will change the whole experience of a car ride; turning cars into moving offices or recreation spaces (Brandt, 2013). All these indicate that on the scale of space perception, ICTs caused and will cause significant changes. It is important to understand the power and impact ICTs have on humans' perception of the world.

3.2. Interiority: Boundaries and perception

The prior example of ICT-embedded automobiles and the change of perception with the help of ICTs indicate the way to perceive a space depends on its intangible features as much as its tangible boundaries. While former approaches to interior architecture are more conservationist dealing with forms, materials, geometry, etc., later approaches recognize that perception of an interior is also affected by feelings, atmosphere, and spatial presence (Taylor, 2018). The latter approach aligns with music changing the perception of automobile interiors from public to private and vice versa.

Interiority is discussed in interior architecture literature to understand the dynamics of space. Interiority is about the recognition and definition of an interior space beyond its physical boundaries, including intangible factors which indicate dynamicity and elasticity (McCarthy, 2005). Interiority can also be explained as the identity or the personality of a space which can be given by taking a holistic approach to the building connecting both the physical envelope and interior elements (Perolini, 2014; Rice, 2007). Taking such an approach needs the involvement of both architects and interior architects in the design and actualisation processes.

Interiority is considered an abstract concept without a concrete definition or formula, with changing boundaries (McCarthy, 2005; Perolini, 2014). It is rooted in the relationship between humans and built spaces, which at its core is based on the sensory channels of humans. Advances in interactive technologies, with the ability to interact in real-time and be sensory-inclusive, reflect changes in the engagement with built spaces on both physical and psychological levels (Taylor, 2018). The way electricity changed the daily routines and perception of spaces at night is given as a concrete example of the power technology holds on space perception (McCarthy, 2005). Similar to the effect of ICTs on products, ICTs hold potential effects on interiority – both on tangible and intangible factors, which reflects the importance of understanding the dynamics of space and investigating potential applications of new interactions.

3.3. Architecture: Meaning of a space as a data system

Though cars offer interior spaces, it differs a lot from the built environment as it limits body movement. Cars' main purpose is transportation, while architecture's main purpose is to create a whole living environment for humans, benefiting from science, art, and technology. Architecture has far more variables, humane and social requirements than a transportation machine. The need for a shelter is essential, even though the form of it changed through centuries. While nature is inclusive to architecture, architecture itself is inclusive to humans. The relation between body and space, along with the main purpose of architecture is constant. All senses work together and come from the skin, and architecture is perceived through them all (Pallasmaa, 2005). They are altered, specialized versions of the skin itself, making the whole body the sensing channel – an asset in the system. Architecture uses visual and volumetric clues to guide its inhabitants along with peripheral senses, indicating an information system in which the built environment is the source and the inhabitants are recipients. Architecture in its nature is a user-oriented process, it offers more than form and function. Architecture without the inhabitants is meaningless and the 'Delight' of inhabitants is considered essential for architecture (Glanville, 2009; Pallasmaa, 2005; Wright, 1953; Le Corbusier, 1923/2013). Factors of 'delight' vary in different cultures or in time, but it is required to adapt to changes in society and inhabitants' needs (Chalk, 1966/1999; Fuller, 1929/2007). Technology, in general, is seen as a way to answer these needs even before ICTs emerged (Haque, 2007; van der Rohe, 1950/2007).

Richard Buckminster Fuller, Cedric Price, Yona Friedman, Archigram, and Superstudio supported the idea of technology as a servant of humans. They didn't deny technology and its added value, offer systematic approaches, and use technology as a way to enhance the human-space relationship. Fuller's geodesic domes – 1967 – offered adaptive climatization, Cedric Price's Fun Palace – 1964 – turns building into a mechanical organism by having no fixed elements inside the building other than load-bearing elements allowing changing spaces inside (Hatch, 1974; Price & Littlewood, 1968). Superstudio's Continuous Monument – 1969 – and Yona Friedman's Spatial City – 1959 – offer a similar approach of transferrable, repeatable, and dynamic architecture with flexible modules (Quesada, 2011; Gürbüz, 2009). Archigram created the utopian concept of giant moving structures/machines equal to cities in their Walking Cities vision, that can move without the restrictions of land and boundaries. Sadler (2005) states that even though this concept raised several questions, Walking Cities stands as a reminder of what modernist ambitions once about, extending human domination and giving value to inhabitants' relation to society, and environmental elements. On an individual or a small group scale, product-like architectural concepts were offered by Fuller and Archigram. Fuller's Dymaxion House concept was designed as a mechanism in which spaces can be altered at the inhabitant's will easily. Fuller intended to create a mass-produced house, with a similar understanding and production of automobiles (Baldwin, 1997). He tried to design with fewer materials and more dynamicity, using inflatable or continuous, changing elements in the house, with an attitude of involving natural principles in the whole process of living, doing more with less (Baldwin, 1997). Archigram's Cushicle/Suitaloon concept consists of a portable mechanical system – a product – that can be inflated to create a personal space regardless of location. The perspective in this concept takes space as an extension of the body, using the flexibility and dynamicity the human body offers to create a modifiable space. All these concepts envisioned a future without physical restrictions, making it possible to create adaptive environments to answer the needs of a changing society.

Tendencies in the post-war era to create product-like customizable environments affect contemporary architecture and 21st-century architecture is using ICTs and sensor technologies to answer these tendencies (Onbay, 2009). The user-oriented basis of Interaction Design along with new ICTs related tools and techniques gives architecture new tools to create responsive, adaptive, and inclusive spaces. ICTs, especially computers, altered the relationship between space and inhabitant into a more dynamic relation, causing a change in the experience of architecture and space (Ak, 2006; Bouman, 2005). Initial integration of ICTs in architecture was to control physical environment conditions, using informational systems to adjust heating, air conditioning, lighting, etc.

Research on the architectural relevance of ICTs increased after the 1990s with the wide use of computers. MIT Tangible Media Group, PHILIPS Design, DSRYN, and many architects investigated ways to include ICTs into spaces. MIT's ambientROOM, House_n Consortium projects offered adaptive spaces embedded with natural ways of interaction to answer inhabitants' needs on different scales. PHILIPS Design's Reading Room 2020 concept offers a consultation room embedded with ICTs without the domination of screens. As stated on their website (URL-4), the goal is to create a non-disruptive knowledge-sharing environment that benefits from technology. On the perspective of overcoming the dominance of technology and creating technology-supported experiences, several other concept projects are built such as Blur Building, Hyperbody Interactive Wall, and deCOi's Hyposurface. Blur Building of 2002 Swiss EXPO is a lightweight structure placed over the lake to create a special foggy atmosphere by offering a space experience without walls but with limited vision. After visitors are tagged according to their answer in the pre-enter questionnaire, and when they encounter others inside the building, they are informed about their similarities and differences subtly (Picon, 2010). Designers aim to eliminate the dominance of audial and visual interaction channels with fog to create deeper interaction with other visitors. Hyperbody Interactive Wall and Hyposurface are very similar as they both offer dynamic partition elements that change their shapes when interacting with a person from different interaction channels such as movement, light, and sound. Lines: an Interactive Sound Art Exhibition in 2016, Umeå, demonstrates a new interaction of body and space to create music (URL-5). When visitors touch, caress or place objects on the coloured lines across the walls and floor, they create music. All these concepts focus on the individuals' input into space and try to reach the diversity of natural interaction channels of humans.

4. Discussion

Information and Communication Technologies altered daily life in several aspects with new mediums to interact, communicate and create, and these mediums became essential to today's living. Both digital and physical worlds are enriched with both great offerings and disadvantages. While the ability of computing, executing complex tasks at ease, availability of information without boundaries are innovative; lack of sensory diversity, physical dominance of technology, static products and spaces can be counted as the disadvantages that arose with ICTs. Though, with developments in ICTs and supportive technologies such as AI, AmI, AR, etc., these problems will be eliminated gradually. Technologies about the landscape and the mind of the digital world hold valuable ideas and future possibilities to create a well-functioning interface between the two dimensions: physical and digital.

Lack of sensory diversity, one of the main disadvantages that ICTs brought to life, is a widely discussed topic both on architecture, product design, and HCI. Humans' natural interaction with their surroundings, objects, and other living beings holds important clues. Cybernetics, being the core of computing, emerged from analysing this interaction system. Technology is a way to enhance human life not a way to place limitations on it. Architecture also serves its inhabitants, creating 'delight'. Therefore, it is possible to state that human values and needs are essential both in technology and architecture, and these two are connected. While technology and architecture seem to place humans in the centre, contemporary life focuses on a fragment of humans by turning into mainly visual culture. Humans sense with their whole body not just with their eyes or ears, but both with primary and peripheral senses. Therefore, creating mediums mainly based on visuals cause problematic or limited interactions. User interfaces evolved from CUIs to GUIs to TUIs and to Next Gen. UIs to eliminate these limitations of being based on just a few senses. First generations of UIs depend more on visual and auditory channels. In later generations, tactile and whole-body interactions are included in UIs, and existing visual and auditory interactions are enriched. UIs became more adaptive, responsive, and manipulatable. The goal of HCI altered from executing specific tasks to create a natural interaction.

Similar to initial UIs architecture became an object of visual satisfaction. This is criticised by architects such as Le Corbusier, Frank Lloyd Wright, etc as architecture is dealt with as a matter of vision rather than answering the varying needs of human living. Discussions in the post-war era and criticism of modern architecture are aligned with the ones about products as they both address the rich diversity of human senses. For the last decades, AI, AmI, and supportive technologies such as IoTs are used in architecture to create multisensory experiences. When the core values of HCI and architecture are compared, it is possible to say that both aim to achieve natural interaction at most. The way of interaction becomes more natural as the limitations and interruptions of initial ICTs decrease with developments in the field.

Another disadvantage emergence of ICTs caused is the domination of technology in daily life. Technology dominated interiors and life with the products born out of it. These products appeared as black boxes with screens and buttons. As UIs evolve, host products become altered. ICT-embedded products become smaller and portable, and existing products such as wearables or automobiles are integrated with ICTs. The effect of ICTs on interiority can be seen in automobiles.

The integration of ICTs in automobiles began with music systems and indicates that even intangible mediums hold the power to change users' perceptions about products and their surrounding space. Recent driving tools and future concepts of self-driving cars have the potential to alter the whole experience of cars, turning their interior into recreational space. The driving experience of today is also enriched with ICTs using AR systems to inform drivers without distracting them. As ICTs become more ubiquitous both physically and digitally, the domination of technology decreases. Next Gen. UIs offer more organic and natural interactions, and host products, therefore it is possible to say they will and are affecting designing principles. Design process of a static product and a shape-shifting or living-embedded product such as SecondSkin would differ drastically. As the restrictions on physical attributes of ICTs hosts decreased, the host itself along with the nature of actions will change again.

One of the disadvantages of ICTs is though they offer a high level of flexibility and a vast variety of actions in the digital domain, they are not responsive enough to match human dynamicity. Humans are not static entities, their habits, wants, needs change constantly. In contrast, products and built-environment are designed to be static, not meeting with the dynamicity of humans. To achieve a rich conversative environment, spaces should be able to adapt and match human dynamicity. Architecture is a system activity and its pattern suits the information system flow, architecture being the source and inhabitants being recipients. ICTs such as AIs, IoT, etc. brought the opportunity to turn this system into a communication system. Even though architects are the designers of a building and create a possible space, and interior architects define interiority, inhabitants are the actual users living and changing with that space. Even though the architecture is static, interiority and inhabitants are dynamic. Inhabitants' contribution is essential, though it is underestimated. As each asset in a system is an observer whether their perception, observation, and interpretation differ, when the built environment is considered as a source, the message of the space gains importance. And this message needs to be implemented into space carefully considering these arguments.

Futurist architects such as Fuller, Friedman, Archigram, and Superstudio criticised the static design of built environments, offered systematic approaches to meet with inhabitant's flexibility. Their concepts envisioned a future without physical restrictions, making it possible to create adaptive environments to answer the needs of changing society. Even though these concepts are still questionable in the means of construction, core values of them such as inhabitant involvement and a systematic approach to meet users' needs are still up-to-date. At this point, it is possible to claim that ICTs offer ways to enhance human life and their environment, with systematic approach and needed flexibility. Shapeshifting interactive space elements, responsive interiors are actualized with help of ICTs. Though these still do not meet the level of flexibility or diversity in post-war era design concepts or the actual human dynamicity, they can be considered as starting points. Examples of dynamicity in the built environment, such as Hyposurface, Hyperbody Interactive Wall, Blur Building, and Lines exhibition along with the visions about the nature of architecture, its relevance to technology, and developments in ICTs indicate that architecture is becoming the host of ICTs to enhance and restore human-space relationship along with the ability to create new experiences.

5. Conclusion

The physical and digital worlds are merging more and more with developments in ICTs. While UI was mainly a matter of interaction and product design, UIs begin to merge into spaces, turning physical walls into screens, creating non-physical but touchable buttons. Interior spaces are gaining interactive features that once were implemented products. Product Design profession dealt with these features from user experience perspective for several decades. ICT embedded products went through the issues of being dominated by technology, lacking sensory diversity, and not meeting human dynamicity. Product designers gathered valuable insights on implementing these technologies. On the other hand, even though architects dealt with ICTs on the information systems level, communication systems are new to this practice. Interiors are becoming products, consisting of conventional building elements, ICTs, and user interfaces all at once, gaining new tools to enrich interiority. Therefore, it can be claimed that the nature of architecture and creating built environment are becoming more interdisciplinary and to achieve a natural interaction with interiors it is crucial to have a collaboration between architects, HCI practitioners, ICT developers, and product designers, as each profession have a different but complementary perspective.

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