FROM EVOLUTION IOT TO REVOLUTION OF DESIGN PROFESSION

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Abstract

The main purpose of the study is to determine how transforming power of IOT may affect the unique system of knowledge of the industrial design field in terms of legitimacy, practice, and education. The investigation is based on the larger question of whether IOT functions as transducer on jurisdictional boundaries of field and how the new tasks and work activities of industrial design field may response in general. Answering these questions will bring community closer to understanding of the need of a different designer formulation, a possible sub-field within the design discipline and ways of how future practitioners and to strengthen their career lifespan.

1. INTRODUCTION

The definition, structure, and fruitful products of Internet of Things (IoT) are rapidly evolving. The evolving idea on connected and communicating devices with each other have direct inevitable influences on end product related disciplines due to the proliferation of new consumer-based creative business models. For this reason, it is not possible for industrial design discipline to remain indifferent to these developments. Yet the professions do not exist in a vacuum, in accordance with its own logic of total evolution, the design discipline needs to monitor and evaluate the developments in IoT, and take necessary precautions and complete transformations in its jurisdictional boundaries, simply to control the provision of related particular design service and activities. Since jurisdiction serves as a key link between a profession and its work [1], in this study, we will attempt to question first, the unique system of knowledge and then the expanding the jurisdictional boundaries of the industrial design field in terms of legitimacy, practice, and education under the influence of the transforming power of IoT. But before anything else, first, we will focus on the major transformations in IoT and how the IoT is changing business models. The main reason for emphasizing business models is to determine the role of the designer in each model and to define the new tasks and work activities to understand changes in future design professionalization. Since our predictions are about the future, surely there will be many minor errors to remain. However, we believe that our modest effort will be the basis for many future discussions.

2. THE EVOLUTION OF IOT AND PROLIFERATION OF NEW BUSINESS MODELS

Like all living organisms, the IoT continues to develop and grow. The pioneer IoT 1.0 was simply about the interaction between Internet, things and data; now transforming to IoT 2.0, which creates the value for the business and also the people; the end-user (Figure 1). When the current state of the IoT and its possible evolutionary development line are examined in detail, a five-step evolution can be observed and predicted to reach value based practical IoT applications. The first step, we can clearly define, is the birth

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of connected and intelligent devices, which have been experienced, such as IoT solutions developed for smartphones. The second stage we are currently experiencing is data collection from these devices with the help of advances in sensors and storage technology. The next stage of the IoT will be management and access to large amounts of collected data sets. In a later stage, the real value of the data will be obtained through the use of complex analytics to sort out, organize, and evaluate the required parts of the gigantic amount of data. In the ultimate step that we have foreseen so far, the unique value of the IoT will be finally expressed through practical value-added services and applications for the benefit of the connected society.
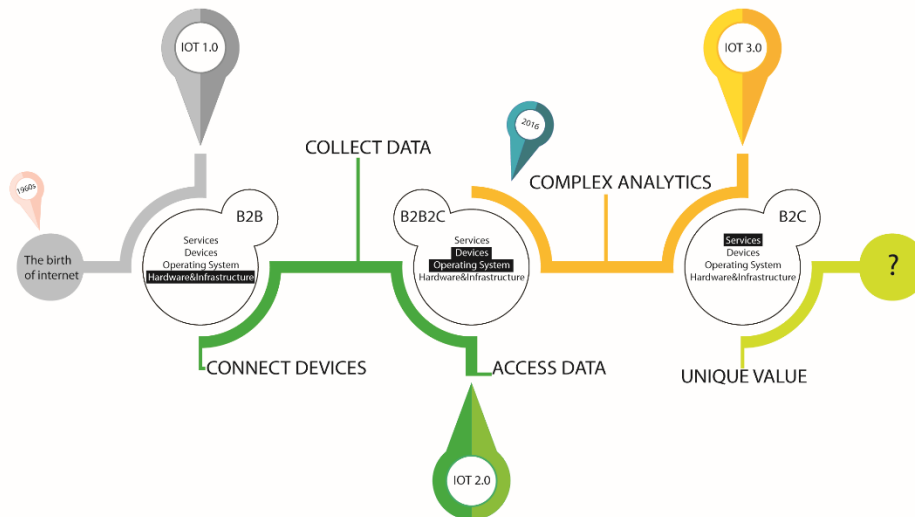

Fig. 1 The evolution of IOT. Copyright © 2017 Güneş and Güneş.

Every step in this five-stage model has a different developmental focus in terms of technological innovation. In the first stages of IoT, hardware and infrastructure investments and development efforts have intensified to connect the intelligent devices together. In the current phase of the IoT, the focus is on the development of operating systems and user friendly connected product design for collecting and analyzing data. In the later stages of IoT, service design will come to the forefront to create unique value for the end-user. The important point here is that connected product design is becoming increasingly important in the IoT 2.0 stage for the prodigious amount of new data utilization and analysis by combining smart components in countless ways. According to Porter and Heppelmann (2014) [2], previous IT waves transformed the value-chain, however "products themselves were largely unaffected". But in the third wave (described as IoT), IT is becoming an "integral part of the product itself" and reshapes value chain, by transforming product design, and improving product functionality and performance.

When our focus is on creating value for the end-user, we observe that different, but occasionally mixed business models come to the fore among the IoT versions. Although it is difficult to definitively classify, it is not wrong to assert that the three business models are at the forefront in the light of contemporary business practices. The most classic B2B (business-to-business; also known as e-biz) approach is a business model that is practiced extensively in the IoT 1.0. B2B describes commerce transactions between businesses, such as between a technology vendor and a larger enterprise buyer. B2B is essentially a supply system where the buyer is also the user of the technology solution. The B2C (Business-to-Consumer, also known as retail) refers to the tactics and best practices used to promote IoT solutions among end users. The B2C model is less common, yet it requires the cooperation of technology vendors to supply end-to-end solutions as well as a more advanced system and talents in retail campaign abilities. The B2B2C (Business to business to consumer; also known as indirect distribution) is a hybrid

emerging IoT model that combines B2B and B2C where a service provider (specialist companies) buys and assembles an IoT solution then re-sells the IoT solution to end user for a complete product or service transaction. What is special about B2B2C is the potential consumerization of IoT and the companies' opportunity to sell IoT embedded products directly to end users and chance to consider and collect the experience from them. The tectonic shift of IoT 1.0 to local creates a boarder range of commercial opportunities and B2B businesses are now inching towards B2B2C, which has led to new expectations and behaviors of traditional B2B customer interactions [3]. The B2B2C's greater focus on the end user provokes B2B manufacturers to re-evaluate their conventional B2B products based on the changing demands of the market. The success in B2B2C segment depends on the ability to meet the market needs, and product design will be critical to getting consumers to adopt offerings in the local IoT world [3]. There are some justifications for their vision about design. When IoT technology and end users meet in a real sense, it will be important how people will use and experience this technology. In this way, we will have a chance to observe the real world effects of the technological solutions existing in B2B today. The integration of the product design with the IoT solutions will enable the consumerization of IoT solutions.

3. SMART PRODUCTS

Information technology is revolutionizing conventional products. The changing nature of "things" is pushing designers to rethink nearly everything they did in the past. They are also reshaping and enlarging jurisdictional boundaries and creating entirely new and inevitable multidisciplinary and also cross-functional intersections. In this chapter, in the context of IoT evolution, we will discuss how design discipline will develop, how will it relate to other disciplines, and what kind of work will determine what designers do.

In order to carry out such a discussion, it is necessary to first define what a smart product is and what are its components. Actually, the meaning of smart product differs in diverse perspectives. The systematic literature review of Gutiérrez and et. al. (2013) shows that there are several different but complementary definitions for the concept of a smart product [4]. According to different definitions, a smart product is an autonomous object (and also a software, or service [5] which is designed for self-organized embedding into different environments in the course of its life-cycle (product innovation, applications and services) and which allows for a natural product-to-human, (environment, other products and systems [6]) interaction. Within this scope, smart product design is defined as Gutiérrez and et. al. (2013) points out "… all studies that focus on the design of new products, such as the design process and the design of human-machine or machine-machine interfaces" (p.207) [4].

A smart product basically consists of three primary components (Figure 2). Smart components (the sensors, microprocessors, data storage, controls, software, and, typically, an embedded operating system and enhanced user interface) amplify the capabilities and value of the physical ones (the product's mechanical and electrical parts), where connectivity components (the ports, antennae, and protocols enabling wired or wireless connections) amplifies the capabilities and value of the smart ones and enables some of them to exist outside the physical product itself [2]. We partially agree with Porter and Heppelmann's amplify-based order; however, we think that there are some shortcomings in the context of the inter-relationship between components, yet the "amplify" feature is described in a one-way manner in the description sequence. Uni-directionality neglects, for example, the influence of physical design improvements on smart ones. As is true for most IT-based physical products such as smartphones, the interdependent components of the device can't be divided in to clear-cut parts.
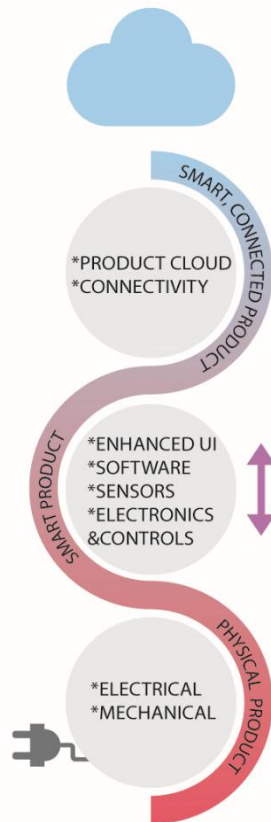
Fig. 2 The architecture of a smart product. Copyright © 2017 Güneş and Güneş.

Indeed, one must consider of those components distributed along a continuum, which has gray multidisciplinary zones, such as mechatronics. In smart products, at one polar of this continuum are crowded by virtually connected world and services, and at the opposite end are bunched by physical world and end-users. At the mid-region of the continuum, smart components are located between these two poles, which are aiming to combine the virtual and the physical, and vice versa. If the reader keeps this concept of the continuum in mind, the gray zones of the smart product continuum refer to a space of cooperation, competition, collaboration, and also conflict between professions. By explicitly conceptualizing the two poles and the continuum in between, the coherence of the cooperation of professions is dramatically increased. For this reason, the contributing professions in the smart product design and their relationship to each other deserve a separate academic interest. If a smart product offers something more from its embedded technology, however, this can only be achieved by appropriate product design, its users will deliver some real value. Smart products have a lot of features differs them from other non-smart ones. Each feature introduces new sets of challenges and opportunities when designing products.

3.1 High levels of autonomy

Smart products can act as an autonomous decision maker that proactively function separately or independently due to their ability to process information by collecting information about their connected environment. A smart alarm clock, for example, may learn users' daily routines, may have sensors to identify when a person is in a lighter stage of sleep and may decide for the exact time to awaken people from their night's sleep. The autonomy of the product is something which an end-user assigns responsibility and delegates authority to the smart product to carry out the work on his behalf. Product

autonomy has its advantages, on the other hand, consumers may perceive autonomous products as more difficult to understand and use [7] than products with lower levels of autonomy due to levels of complexity and perceived risk [8].

3.2 High levels of complexity

Complexity in installation, setup and operations are the new reality in smart product due to the mix of software, firmware, hardware, and interface both for the process of development and usage. Smart and connected products bring additional complexity even for a frequent user yet the functions they offer are difficult to learn and use, exceed the ability of the most users to learn or many functions may remain "untouched until the end of the product life" [9]. To overcome the complexity and to achieve simplicity is, paradoxically, a result of massively complex ideation. As it is difficult to do simple, as Mühlhäuser (2007) states "mastering the simplicity paradox will be deterministic for product success" (p.158) and IT "must be applied in novel ways for improving the simplicity" (p.160) [5].

3.3 Being always on/connected

Data retrieval and sharing are the most important reasons for the existence of smart products. The regular exchange of information generates vast quantities of data that elicits a sense of being always connected. By virtue of always being connected and tightly integrated into a network, the users encounter a variety of challenges and risks such as losing control of huge data flow they generate and lower safety in privacy. Safety and usability are two sides of the same coin – both are used to assure the best function, and neither works very well without each other.

3.4 Being a part of a connected community

In a connected world, it is not possible for a product to exist alone. For this reason, every node product in the network should be discussed together with its product territory and community of users to which it belongs. The smart products provide the experience of presence (or being there) and also co-presence (being there together) which elicits a community feeling and enables shared experiences [10]. Designers should develop system thinking practices for addressing complexity in a connected product ecosystem and shared experiences.

3.5 Upgrades and extended product lifespan

Smart, connected products can be continually upgraded via software [2] or can gain new features by third party applications. These devices do not die when they have enough required hardware for the upgrade till the end-of-support. Each upgrade or application installation presents particular new challenges that must be learned by the product users. For this reason, smart products designs must be built through the basis of life cycle thinking that lets them run on a range of their lifespan.

4. REVOLUTION OF DESIGN PROFESSION

In the course of time, professional boundaries in industrial design faced a compulsion due to product diversity, technological improvements, and consumer preferences and behaviors. In smart product era, every industrial designer is on the path to becoming a connected product designer yet they require a whole set of new design principles and fund of knowledge that enable product customization, personalization, upgrades, and also predictive, enhanced and remote service.

The following part offers a brief theoretical overview of the key literature on professions and their jurisdictional boundaries. We structure and limit our review of expert body of knowledge, jurisdictional

control, and team/client relations in connected product design to demonstrate how the industrial design profession will act and perhaps survive in the complex system of IoT.

The historical argument on jurisdiction is built around the knowledge base [11] and as Mclaughlin and Webster (1998) discuss the knowledge claims act as an important discourse to achieve a jurisdictional control and expert or professional status [12]. Yet the professions are institutions that built on knowledge [1], professions adjust the jurisdictional goal, according to their knowledge claims by applying somewhat abstract knowledge to particular cases to secure and maintain their status [12]. The skills that characterize a profession flow are supported by a fund of knowledge [13] and professionals act as the bearers of expert knowledge [14]. The expert knowledge can be seen as a source of professional power [15], on the other hand, the knowledge that professionals need is constantly changing. This constant change in the knowledge rebuilds the interdependence among the professions. According to Abbott (1988), professions constitute an interdependent system (known as The System of Professions) and changes in one affects the other [1]. Change happens within professions through two sources: one is from external factors, such as, as Abbott (1988) states "opening or closing [of] areas for jurisdiction and by existing or new professions seeking new ground" (p.90) and another comes from internal factors through the development of new knowledge [1]. According to DiMaggio (1989) "professions grow when there are niches for them to grow into; they change when other professions threaten their control of particular kinds of work" (p.534) [16]. The changes brought about by technological developments may inevitably require a certain profession to change and sometimes even to remain. That's why it's key to understand the new tasks and work activities of industrial design in IoT era to control the future changes in its jurisdiction. Therefore, awareness, accumulation, and control of IoT-specific knowledge of designer in the connected world and its applications means competence in work, effectiveness in a multidisciplinary teamwork, and even domination over outsiders who attack that control. Due to the reasons we have discussed above, the body of knowledge of product designer should to be redefined to formulate the short and long-term goals for the connected world. According to Industrial Design Institute (2014), the collective intellectual and experiential knowledge of a profession can be defined as its body of knowledge which is organic and evolves and continues to grow minute by minute, day by day [17]. Basically, industrial design uses a methodical process which centers on the human to meet physical, social, and physiological wants by the products. It creatively plays and balances many competing factors into a single, visible, tangible expression of an object that can serve to help people, excite people, and make lives better [17]. As the complexity of the IoT products grows, the complexity of the industrial design and the necessity of including content in the area grow to solve complex multidisciplinary problems of connected human behavior and design. This is why we should answer what different knowledge connected design effort needs and how the use of specific knowledge contributes to the IoT world to prepare current and future practitioners and to strengthen their career lifespan.

In a very general sense, the body of design knowledge consists of knowledge about things and their relationships and also knowledge about design procedures and methods such as design management, commissioning, contract and copyright knowledge, design organization or design theory. These two kinds of knowledge are composed of two sets of information which are interdependent: factual and episodic knowledge. Factual knowledge is independent of person and a learned knowledge gained through instruction and from external sources in an explicit manner. Episodic knowledge is more tacit and based on experiences that chunked by episodes [18]; knowledge of specific personal career experiences. The information designers need to be able to cope with the IoT will be both factual and episodic. Since factual information is more encoded, it can be obtained through modified design education. Episodic knowledge is sui generis in every individual because of the tacit nature, therefore, they will be learned from experiences but hardly transferred. The interlinked nature of both factual and episodic knowledge forms a rational for an inevitable multidisciplinary effort to gain new sets of information both in design education and practice yet the designer cannot take all the aspects related to the complexity of IoT product. To reach a sufficient level of expertise to cope with the advances in digital technologies requires first, awareness and attention then an investment of time on collaborative practices.

Love (2002) defines key design elements as human, object, and context [19]. The interaction of these three elements in various ways determines the focus of different design research [19]. The most complex of these combinations, perhaps, is the interaction of human(s), object(s) and contexts together. The

complex relationship between these elements requires, as Love (2002) states, "a coherent and unified body of knowledge of various disciplines" (p.349) [19]. When thinking of the IoT world, the key elements of designing dramatically transform to: human to connected human, object of a smart product and context to whole IoT world. This new case necessitates that the designer needs to generate new domain specific information when working with new IoT paradigm. According to Popovic (2004), "domain-specific knowledge plays a significant role" (p.527) in being an expert and as the design is categorized as an "adaptive expertise", expert designers are in need to use new domain specific knowledge which they adapt to the current tasks [20]. Therefore, in the following sections, we will try to specify the types of new domain specific knowledge that the designer needs in IoT era.

4.1 Network Logic as a Design Principle

The Network Society theory implies that networks shape a new world order. In the network society, which also means a paradigm shift, all institutions are organized in a network between themselves and within themselves [21]. The network society theory points to the changes in the characteristic structures of individuals, their ways of understanding the world, and the emergence of new forms of communication. On the other hand, Connectivism, the thesis "that could be described as distributed knowledge" (p.77) across a network of connections [22], is an approach, that explains learning about networks as learning theory of the digital age. Connectivism consists of three different combinations of thought: chaos theory, the importance of networks, and the interplay of complexity and self-organization [23] and is based on five basic principles: autonomy, diversity, connectedness, interactivity, and openness [22]. These five principles are actually the IoT context itself. The products that come out with technology are the parts that enhance the accessibility of our bodies and senses [24]. While this is the case, the IoT products will present the five principles as an extension of the human being. This condition inevitably requires designers to internalize the network's logic. Yet the network logic is greater than the sum of its parts, as well as smarter products that will form the tangible IoT, the context of the network itself is also becoming an important design input and output to act in the novel ways of social interaction. As each separate smart design entity will act just a part of a larger network, to say the least, product designers should know and be aware of how the data moves through the network (pattern of the data flow in a network), basic networking fundamentals such as networking concepts, network architecture, network communications and network design to position their product in the whole.

4.2 Scale Matters

For the designers, one of the most challenging elements in the IoT world will be its scale. IOT scale will bring connectivity, complexity and probably catastrophe which makes it extremely challenging to control. The enormous scale of an IoT like system depends on its smart parts and the interactions between those parts where the whole often seems to take on a form that is not recognizable from the parts due to interactive parts, which affect each other through complex networks of relationships [25]. Any change in a part cascade through an increasing number of connected parts, in part feeding back, positively and/or negatively, into the initial part and the whole which gives meaning to the parts and their interactions [25]. As dividing an elephant in half does not produce two small elephants [26] and vice versa; inability to see the scale of the IoT system as a whole can create a world of problems for a designer who just independently motivated on a unique product in the whole. The nonlinear, unpredictable and self-organizing system characteristics of chaotic IoT increases the importance of every product that will participate in the system yet the IoT is sensitive and dependent to its constantly renewing initial conditions. For this reason, it is necessary for designers think holistically [27] and to develop a set of system thinking habits or practices to cope with the scale created by the chaotic IoT system.

4.3 Perfecting the Art of Design Teamwork

According to Buurman (1997), "the design of smart products can no longer be done properly by a single individual, no matter how gifted and well trained that person is" (p.1165) [28]. Smart objects demand new balance of skills that are distributed along various disciplines. To take all advantages that IOT has to offer, product designers should work much more closely and collaboratively beneath a certain amount of careful planning and organization. Being in a team causes diverse difficulties and opportunities for the designer yet the task specific information has to be gathered from a variety of sources [29]. Smart product design is a process that requires new type interdependent information for the multidisciplinary team, due to different product components, functions, and services. In such a case, team members will inevitably contact with a completely different body of knowledge relatively resting on different assumptions, problem-solving approaches, cultures, motivations, and purposes of the agents and also are in need to incorporate and update collaborative work philosophies to accommodate IoT-specific requirements. We believe that successful IoT-specific design processes should not be a jurisdictional arena where a dominant profession will fight to maintain its turf, it will be in a shared-based talent and knowledge pool where professions strive to understand each other to elevate their best practices to manage the process. In order for this to happen, the disciplines involved in the design process should review and evaluate their body of knowledge to reveal gaps in knowledge and should build bridges between each other to generate new, related propositions and to define existing ones.

4.4 ID 103 Service Design

A typical smart product is not static, it is connected and supported by intangible functionalities; namely services [30]. Being always connected has a great impact on product design, uses and service design within different cultures due to the complex offerings, involving multiple and different types of users, touchpoints and use contexts [31]. As "design components play a critical role in the development of Product/Service Systems (PSSs)" (Morelli, 2002, p.3) [30], new skills and new ways of understanding are required, especially "knowledge of the social sciences, of story construction, of back-stage operations, and of interaction" (Norman, 2010; p.5) [32] which can "help designers to lessen the drawbacks" in smart PSSs design and "play a central role for the value-creation-in-use" [27]. These areas were formerly sheltered by diverse domains but may provide designers a necessary expertise to manage the particular characteristics of PSSs [30]. According to Norman (2010), designer candidates are not well equipped in the behavioral sciences [32]. Therefore, he discusses the need for a "new breed of designers" who "must know about science and technology, about people and society, about appropriate methods of validation of concepts and proposals about political issues and business methods, operations, and marketing" (p.5) [32] for future product and service interactions. Due to the reasons we have mentioned above, the concept of service design must immediately enter the agenda of the designers and into the curriculum of the educational institutions.

4.5 Electronics, Mechatronics? To Know the Basics.

One problem that experienced in design education is the lack of knowledge on the integration of electronics, mechanics and control systems in a smart way [33]. As the design of smart products require, at least, knowledge of the fundamentals of electronics such as the concept of product data flow diagram, electronic aspects of products (e.g. sensors and their applications), and electronics of embedded systems (e.g. stepper motors, LCD displays, etc.), integration of different levels of electronics courses in design curriculum will facilitate a complete new world of opportunities for the design students. With the spread of mechatronics to all kinds of products and systems for gaining a competitive edge in the modern manufacturing era [34], the understanding of mechatronics will guide designers to solve real world design problems which require the application and mutually allocation of the knowledge in a teamwork composition.

5. GENERAL DISCUSSION and CONCLUDING SPECULATIONS

Throughout our work, we have taken care to define the conventional B2B type of smart product design processes as multidisciplinary. This conscious choice was due to the participation of experts from diverse domains working together, each drawing on their body of knowledge due to the multidisciplinary nature of the IoT 1.0 products and the limited end-user interactions in development. However, it seems that future IoT 2.0 type smart product design process requires more an interdisciplinary effort where professionals integrate and generate B2B2C specific knowledge from different disciplines and use a real synthesis of approaches to create new instruments and models which couldn't occur separately. As we have already mentioned, smart product design process covers the gray zones in the design process continuum which refer to a space of cooperation, competition, collaboration, and also conflict between professions. These gray zones force the collaboration to move from multidisciplinarity to interdisciplinarity. This will lead to a shift in the expertise of the design to routine expertise to more adaptive one or maybe will cause the emergence of a new specialized field within the design profession (i.e. connected product designer or technology designer) with its own body of theories, concepts and models to reduce the need for cross-disciplinary interactions.
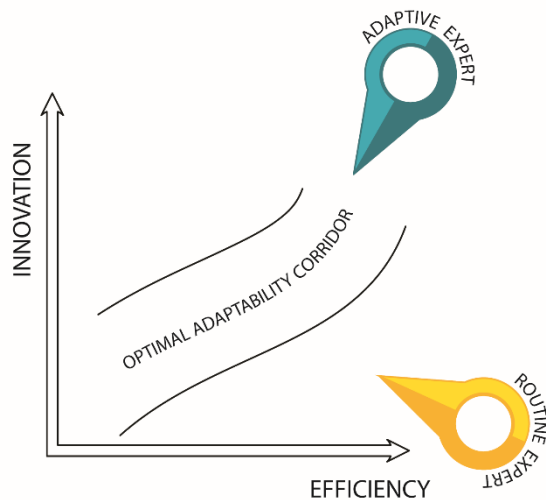

Fig. 3 Visualization of optimal adaptability corridor. Copyright © 2005 Schwartz, Bransford, and Sears [37].

According to Hatano and Inagaki (1986), there are two kinds of expertise: "routine and adaptive" [35]. They state (1986), "routine experts are outstanding in speed, accuracy, and automaticity of performance but lack flexibility and adaptability to new problems" (p.31) [35] and "but often fail to go beyond procedural efficiency" (Hatano and Oura, 2003; p.28) [36]. On the contrary, adaptive experts "can be characterized by their flexibility, innovative, and creative competencies within the domain" (p.28) [36]. Schwartz, Bransford, and Sears (2005) visualized a hypothetical optimal adaptability corridor for the development of adaptive expertise to help ensure that innovation (ordinate) and efficiency (abscissa) develop together (Figure 3) [37]. According to them, "people who are high on efficiency can rapidly retrieve and accurately apply appropriate knowledge and skills to solve" particular sets of problems with lack of variability where people who are high on innovation axis can generate new knowledge and ideas and can leverage existing ones to handle new types of novel problem [37].

The variable nature of the concept of expertise allows us to express some inferences. The first of these is that routine expertise has a multidisciplinary structure due to its own knowledge and interaction limits. Routine expertise in industrial design is something to wrap a piece of technology with a beautiful skin that "excluded from any discussion of the object's interface or software" where "the object was 95% defined, physically, before the designer ever saw it" in throw things over the wall mode [38]. On the other hand, adaptive expertise has an interdisciplinary nature, yet it demands a new balance of skills and expanded body of knowledge. Adaptive expertise in industrial design in IT business is something that designer tries to learn basics of other disciplines in order to facilitate effective dialogue and at the search for what can be done not only physically but also digitally to cope with multi-dimensional design dilemmas.

Change occurs within professions both from external and internal factors [1]. If the profession does not comply with external factors such as the new body of knowledge it corresponds to, this can weaken its motility, synergy, and perhaps jurisdiction. When the new task areas of profession arise due to the dynamic nature of the professions, new specialized hybrid fields within the profession may emerge internally in an adaptive manner. As Dogan (1999) states, this inevitable hybridization "depends largely on exchanges with other disciplines" (p.180) and obligates professionals "to cross the borders of home discipline by integrating into new research factors, variables, theories, concepts, methods and substances generated in other disciplines" (p.180) [39]. In every discipline, there are pioneer professionals who stand "at the margins of their formal discipline" [39] and who borrow and lend body of knowledge at the jurisdictional boundaries to form new specialized fields within the discipline.

In the following part, we will attempt to identify IoT-specific sub-field within the discipline of design, its possible characteristics, and look how it is unique according to new domain specific knowledge that the designer needs in IoT era. Product design comprises a number of sub-fields, each of which produces its own ethos, challenges, and opportunities. The diversity within a discipline is often linked to the conception of variable ontological individuals in each subfield associated with the emergence of new approaches, strategies, and concepts. For example, in economics, the traditional internalist homo economicus conception of the individual represents an ontological point of view of the neoclassical formulation where externalist conceptions of the individual laid the rise of behavioral economics and development of experimental economics. There are a considerable change and development in industrial design field, both on the academic and professional levels associated with the conception of labile individual user ontology in terms of their changing own characteristics, their relation to one another and of course with products.

So, what sort opportunities do these developments provide for us for making inferences for the IoT-based conceptions of the individual user ontology of design? This is the question to ask, because, it can be said that the IoT products realize the principle of real value generation, but only within a certain and accurate individual-based ontological acceptance framework. It is necessary to clarify what kind of changes are open or hidden in the individual ontology and to clarify how the conception of the connected individual contributes to improving the quality of smart products. The fact that the individual ontological assumptions do not reflect the reality will cause the user-based smart products to be erroneously constructed from the very beginning. It is also a fact that the real subject of IoT is no longer a smart product but a connected user. For this reason, a design concept that neglects the revised conception of the user is condemned to failure at the IoT 2.0 level.

As a result of developments in IoT, serious changes are observed in the individual ontology. By the help of the IoT opportunities presented to them, the visibility of always connected individuals are increasing in the public domain and individuals who want to see themselves as a public subject are requesting more active roles in the decision-making and creative processes, observation, assessment, and controls by organizing in the form of a network. They are seeking the means of realizing their own life projects within the constitutionality based on connected society. Today, IoT is a platform on which the conception of the connected individual emerges. The connected individual, the potential user of the smart product, is a person who enters into relations with a larger number of more diverse individuals and with parts of the societal machine [40] itself by complex and fragmented channels, tries to adopt the tempo and the logic of network "at different spatial and temporal scales" [41], uses its fruitful products and acts as a

"rhizomatic" [42] node, generates and exchanges data, and fears and excites to be inside and outside of the network. It is imperative that the marginal designers who will respond to the needs of such a connected individual should have specific knowledge, style of thinking and technical competence by moving ahead from the routine mainstream and toward the borders of design discipline and observing the margins of related ones, in terms of producing a hybrid subfield to overlap and fill gaps in body of knowledge and to provide the grounds for intellectual cross-fertilization at which creative marginality, accumulation of incremental advance and innovation occurs [43].

Throughout our work, we have tried to present IoT with its actual and possible business models, its physical products and connected user ontology associated with the product design. In the light of all these evaluations, it is obvious that the design of IoT products requires a different designer formulation. Another possible implication is the potential for IoT products to create a sub-field within the design discipline. A move to the specialized periphery does not mean to move away from the design field. On the contrary, this refers to the enrichment of the design area, the expansion of its boundaries and jurisdiction. As the specialization subsequently produces gaps between subfields [44], the field of design should enrich its body of knowledge to fill that gap. Successful connected product/technology designers of the future should: internalize the network logic as a design principle, develop a set of system thinking habits or practices to cope with the scale, understand interdisciplinary team members to elevate their best practices to manage the process, be aware of the basics of service design, electronics and mechatronics.

Such necessity also has other critical reasons. In the connected future, talent, more than capital, will represent the critical factor of production and this will segregate job market into low-skill/low-pay and high-skill/high-pay [45]. This means that, in future job market, the demand for high-skilled adaptive designers will increase where the demand for lower-skilled ones will decrease. In the winner-takes-all economy, even the average-skilled ones will not have any chance. As Schwab (2016) states this is why that the average ones increasingly experiencing a pervasive sense of dissatisfaction and unfairness [45]. Moreover, if the design job market segregate at the high and low skill ends this could yield greater inequality, particularly in its potential to disrupt labor markets [46].

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