

The future of interactive furniture: Design opportunities vs. limitations

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Abstract:

Interaction design has become one of the most trending design approaches growing rapidly, developing every usable type of product. It represent according to David Kirsh a new world of physical, natural, and tangible interfaces. We can interact with digital elements by gesturing and body movement, by manipulating everyday objects and even by training brain activity to control interfaces. But interactive furniture design has a very special nature, due to several reasons and factors that affects the process of developing it. Usability and sustainability with their sub-branches like UX could be considered the main source for these reasons and factors, because both of them include and represent nearly all the majority of modern criteria that control designer's way of thinking and all design process. For example, the furniture will be transformed into a kind of electronic product with increasing obsolescence, what will cause an environmental limitation.

In this paper, we criticized the current state of art of interactive furniture and it's suggested conceptual designs, by using the principles of both usability and sustainability. In a try to envision the future of interactive furniture. Exploring both the possible design opportunities, and the limitations, to make it clearer for the designers and encourage them to work creatively on sustainable interactive furniture (SIF).

Key words:

Interaction design, Interactive furniture, Sustainable interactive furniture, Usability and Sustainability.

نبذة مختصرة:

أصبح تصميم التفاعل أحد أكثر أساليب التصميم اتجاهاً في النمو بسرعة ، مما أدى إلى تطوير كل نوع من المنتجات القابلة للاستخدام. وهي تمثل وفقاً لداود كيرش عالماً جديداً من الواجهات المادية والطبيعية والمادية. يمكننا التفاعل مع العناصر الرقمية عن طريق الإيماء وحركة الجسم ، من خلال التلاعب بالأشياء اليومية وحتى عن طريق تدريب نشاط الدماغ للتحكم في الواجهات. لكن تصميم الأثاث التفاعلي له طبيعة خاصة جداً ، وذلك نظراً لعدة أسباب وعوامل تؤثر على عملية تطويره. يمكن اعتبار قابليتها للاستخدام والاستدامة مع فروعها الفرعية مثل UX المصدر الرئيسي لهذه الأسباب والعوامل ، لأن كليهما يشمل ويمثل تقريباً جميع أغلبية المعايير الحديثة التي تتحكم في طريقة تصميم المصمم وكافة عمليات التصميم. على سبيل المثال ، سيتم تحويل الأثاث إلى نوع من المنتجات الإلكترونية مع تزايد التقادم ، ما سيؤدي إلى الحد من البيئة.

في هذه الورقة ، انتقدنا الحالة الراهنة للفن من الأثاث التفاعلي والتصاميم المفاهيمية المقترحة ، وذلك باستخدام مبادئ كل من قابلية الاستخدام والاستدامة. في محاولة لتصوير مستقبل الأثاث التفاعلي. استكشاف كل من فرص التصميم المحتملة ، والقيود ، لجعلها أكثر وضوحاً للمصممين وتشجيعهم على العمل بشكل خلاق على الأثاث التفاعلي المستدام.(SIF)

الكلمات الدالة:

تصميم التفاعل ، والأثاث التفاعلي ، والأثاث التفاعلية المستدامة ، وسهولة الاستخدام والاستدامة.

Introduction

Clutter is problematic in homes, Schools and Workplaces where the furniture can build up rapidly and defeat the efficiency of small-space living. Multifunctional furniture used to have a big effect between humans and the Digital technology is a creative material interfaces with logical and thought out behaviors and actions. Interaction design can combine between them to use digital technology to open new possibilities for making furniture more comfortable, interesting, multifunctional, interactive and informative and more fun. By using interaction design as trend into furniture, it has become more like interactive products that support people in their everyday, Education and working lives.

Furniture trends usually dictated by who is buying what and why they're doing it. According to Jerzy Smardzewski in his book "Furniture Design" these Trends should not be confused with fads, which are fickle. Trends are the undercurrents that drive the results. Some of the forces working behind furniture trends of the 21st century (Jerzy, 2001) include younger buyers and technology. The globe seems to be shrinking, and there's a rising concern for the environment. All this has resulted in some furniture riding a wave of popularity in the millennium. Efficient home design will never go out of style because of a condition that prevails in most households: The amount of stuff coming in exceeds the amount of stuff going out. Clutter is especially problematic in small homes or apartments, where it can build up rapidly and defeat the efficiency of small-space living. The solutions are to reduce the number of objects you own and use specially designed small-space furniture to better organize what you keep (Allabarton, 2016). Transformable space saving furniture which uses less space and provides dual functions is also called dual-function furniture. It has a large potential market in large cities, such as Beijing (China) and New York (the US). These large cities have a lot of features in common. They have large populations, large gaps between rich and poor and a large portion of small space apartments (Preece, 2002). These features provide a good opportunity for the development of interactive furniture. Interactive furniture is designed based on the concept that the furniture's design must involve at least two forms of appearance and/or function, or capable to fulfill user need better way adding new types of relations between the user and the designed furniture. However it should have both an ordinary appearance and high-tech features. That according to Allabarton, one of the challenges for designers of furniture is that the furniture needs to be both aesthetic and functional.

1- Interaction Design

Interaction design is a process in which designers focus on creating engaging interfaces with logical and thought out behaviors and actions (Helen, 2013). Successful interactive design uses technology and principles of good communication to create desired user experiences. There are several somewhat different definitions of "interaction design" in the literature. Interaction design means designing interactive products to support people in their everyday and working lives. In particular, it is about creating user experiences that enhance and extend the way people work, communicate and interact." (Preece. 2002). It is a field with interdisciplinary concerns, since its essence is interaction that includes people and machines, virtual worlds and computer networks, and a diverse array of objects and behaviors. Interaction design makes every day task' tools usable, useful, and fun. Although there is no general agreement on the exact meaning of the term "interaction technique", the most popular

definition is from the computer graphics literature: An interaction technique is a way of using a physical input/output device to perform a generic task in a human-computer dialogue (Lars, 2006). A more recent variation is: user interface technique or input technique is a combination of hardware and software elements that provides a way for computer users to accomplish a single task.

1.1 Interaction Design through UX & Behavior

The official definition of User Experience (UX), is: “A person’s perceptions and responses resulting from the use and/or anticipated use of a product, system or service.” (Allabarton, 2016.). When thinking about UX design, the definition includes how that experience can be manipulated or influenced by the designer to increase the quality of that experience for the user. Specifically, the “design” aspect focuses on how the utility, ease of use, and efficiency in a user’s interaction with a product or service can be improved. Visual design is how a product looks, whereas UX design is, essentially, how it feels. (Preece, 2002). Every time you interact with a product, a software, or an object you are experiencing that as a user of that product. A key UX design skill is therefore learning how to make that experience the best it can be (Klein, 2015). A UX designer’s job is also to be the glue that holds the entire product team together, translating designs to developers who will then implement. But it’s not all about the user. Just as important in the UX design process is meeting the business goals of the product and aligning the business goals with the goals of the user. We use UX design because it improves the experience of the user of that product and increases the adoption of that product and because of the benefits that it generates—happy customers and increased sales. We experience these benefits when the goals of UX design are met. The first thing a UX designer thinks about is how to align the goals of the user with the goals of the business. E.g.: if a user’s goal is to buy a product, then the business goal needs to be making that purchase a **Useful, Usable and Delightful** action (Lars, 2006)

- **Useful:** You need to solve a user’s need, a problem that users actually have.
- **Usable:** Usability needs to be clear so that users understand your product/service.
- **Delightful:** It’s no bad thing if a user enjoys using your product.

Understanding what emotional design should be and emotion's role in various aspects of design, represents not only the goal of this research, but also the goal of much research, since there have been many studies focusing on analyzing it with great success. Some scholars and researchers have regarded emotion in design as a tool that designers use to deliver their messages and feelings, whatever the users’ emotions and feelings are. While others believe that emotions are a kind of experience or response when an individual is using an object. A third group focused mainly on revealing this relationship among users, products, and users’ responses.

However, in addition to Robert Plutchik's model, who classified emotions into eight basic emotions, there are three levels of perception that may provide the required knowledge to deal with emotional product design; these levels are: (Jerzy, 2001).

- **Visceral** (also called reactive): where emotions are quick, evolutionary responses, relevant in regards to the product's visual appearance.

- **Behavioral:** where emotions coincide with bodily activity, and are related to the pleasure and effectiveness of use.
- **Reflective:** where emotions occur at a contemplative level and relate to the rationalization and intellectualization of a product.

These three hierarchical levels of perception are interwoven through any design, and they represent three important axes that can be focused upon in order to find an effective strategy that can be used in creating an emotional design. Perceiving design takes place firstly at the visceral level, and in a deeper sense at the reflective level. This means that design itself should touch the user's feelings through the visual aspect or appearance, as well as by more emotionally in depth design and positive memories that aim at users' satisfaction. The importance of emotions is represented by the objectives that provoke strong positive emotions such as attraction, attachment, and happiness (Ibrahim, 2014). At the same time, emotions follow behavioral and psychological reactions, as cognitive processes are central to emotional experience, and they are more than simply the joint effect of both physical reactions and cognitive appraisal. Emotions should be included in any design or product as a personal component as well.

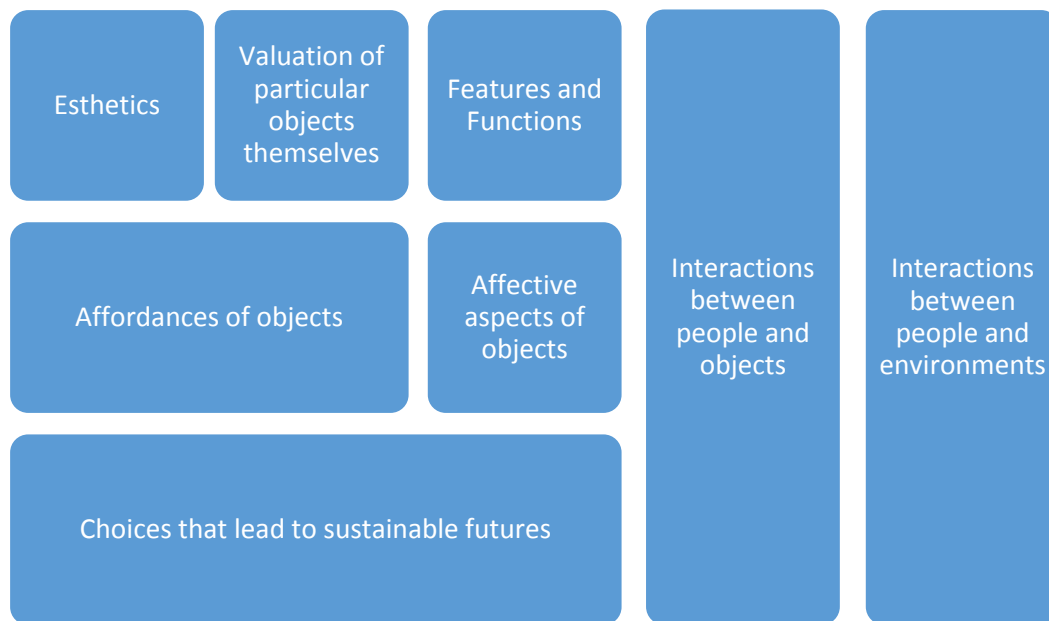
1.2 Interaction design obsolescence and sustainability

Obsolescence of technology, in particular planned obsolescence — is brought upon us by industry (Slade, 2006), where the development and discovery of new technologies and opportunities for interaction enables and worsens obsolescence, since consumers aspire and acquire such new technology (Remy, 2015).

On the other hand, sustainability as design approach, take in consideration the complexity of demand of interactive products. Where the interrelationships between such design aspects as software, hardware, fashion, form, content, marketing, and copyright -according to Blevis, et al.- affects our understanding of a particular interactive device creating a complex morass of effects, many of which have implications for sustainable and unsustainable behaviors.

Remy assumes that the future certainly will come with restrictions and severe changes in human everyday life as well as for industry, these changes also will imply that we have to rethink our approach to research, where the potential changes to consumer's perception towards technology acquisition, industry's goals and focus on production, and the inevitable scarcity of resources, old concepts that were deemed to be unrealistic might become viable and new approaches might arise.

Therefore, design framework and principles endorsing sustainable interactive design such as linking invention to obsolescence, or promoting renewal and reuse become more the focus of design research. And the durability of interactive devices in the presence of changing needs and requirements and in the presence of technological advances must be a part of the design of an interactive device. Design values also has its own effect on design process, where notions shown in (Fig.1) could control and define the final design.



(Fig.1) Notions of design values

Successful interactive design uses technology and principles of good communication to create desired user interactive experiences, producing usable, useful, and fun furniture, considering factors such as (Rosie, 2016):

- Fit in the Environment: The environment the interaction will be going in is the first thing that needs to be considered.
- Strategic Placement: Related to environmental considerations are that of placement. The installation must not be placed in a way where it will interrupt traffic or obstruct visibility in a retail environment.
- Understanding Your Customer: You probably know, from the perspective of your business, what you hope to achieve from the interactive experience.

(<https://realityvi.com/2014/12/09/4-key-factors-good-interactive-experience/>)

2- The nature of Furniture and developing needs

The practice of using natural objects as rudimentary pieces of furniture likely dates to the beginning of human civilization. Early humans are likely to have used tree stumps as seats, rocks as rudimentary tables, and mossy areas for sleeping. (Hallnäs, 2006). By time people start thinking how to benefit from the furniture to fulfill their developing needs, smarter way by using many technics like space saving, multifunctional and sustainable furniture to live more comfortably.

Multi functionality for example, is having or able to perform many functions. Multifunctional furniture bolsters the “less is more” attitude of the tiny-house and minimalist movements. Plus with fewer materials, it can also be a sustainable alternative to traditional furnishings (J.H. Fearless, 2015). Furniture that changes shape on a whim to match different needs is a fun conversation starter. But for some people, a piece that pulls double duty is legitimately beneficial, if not necessary to their lifestyles.

There is many advantages of using multifunctional furniture. Multifunctional furniture saves a lot of space and it's one of the most well-known benefits associated with the use of multifunctional furniture is the space that user get to save. Also multipurpose furniture saves money, where the transformer furniture items in the market are generally quite affordable. Such multifunctional furniture items are generally meant for the use of working professionals (Allabarton, 2016).

There is many examples for multifunctional furniture. Multifunctional combination of stool and shelf by Noon Studio (Fig. 2). Each piece of this shelving unit can be moved around to change the form and function of the piece. Place all the solid sides up to form a table. Break each piece apart for nine stools. Keep some together to make shelves and a coffee table, and keep others as individual seats. The possibilities are limited by your imagination and the number of stools you have to work with.



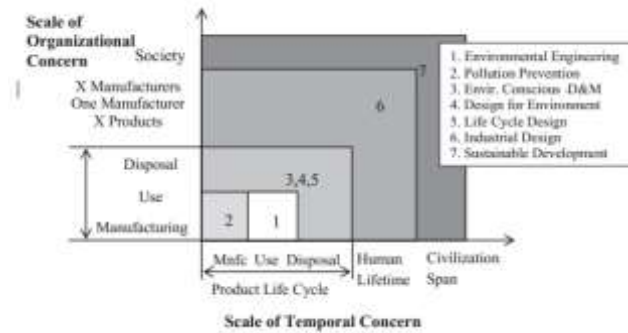
(Fig. 2) combination of stool and shelf by Noon Studio

Furniture can be designed and produced for various purposes and it depends on how well serves in use, and leads to efficiency, effectiveness and satisfaction for users. For furniture there are different Factors that affect furniture design are: form (art, style), function (the strength and durability, area, place, usability), material (appropriate function, mechanical properties), costs, safety and sustainability. However Usability is the most imperative requirements that a product of furniture is expected to fulfil

When evaluate the usability of furniture, aesthetic and semiotic aspects can have some weight, but usually the focus is on the ergonomic requirements of use: dimensions and the limits of their adjustment for persons of different stature, ease of moving the piece of furniture, smoothness of its surfaces, and many mechanical features. In another words, usability means the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use. (Prekrat, Pervan, SmardzewskiI, 2013)

On the other hand, dealing with furniture as a product, companies and organization recently have been working on reducing the negative environmental impacts of their products throughout their life cycle. In doing so, several approaches have been set. These approaches can be classified as shown in (Fig. 3). The life span of products, people and civilization can affect the gradation on the scale (Bras, 1997). Sustainability of a product dictates that its product life span must be considered to reduce the environmental impact of it efficiently throughout its whole life cycle. In this Figure, Design of Environment and Life-Cycle Design concepts must be incorporated for successful sustainable design. In addition, product use and disposal are necessary for sustainability so that End-of-Life Options can be integrated into

sustainable design consideration. Therefore, sustainable design approaches should go beyond simple product life cycles and consider second life opportunities and options. (Uysal, 2014)



(Fig. 3). Environmental and temporal scale of environmental impact reduction approaches

In the context of sustainability, materials used in the production process and the long term use of the furniture are the major criterions. Achieving sustainable furniture, recycling is one of the important criterions, so some of the furniture companies started producing furniture totally from waste. Furniture produced from waste sometimes rejected due to the problem of aesthetics and these types of furniture are sometimes considered as unaesthetic. This is the main problem in selecting this furniture. (Ayalp, 2012)

2.1 Usability and emotions

Good usability equals the absence of usability defects (e.g. Kanis 1997, Hollnagel 1997). Quite a number of ideas have been presented from varying perspectives, including emotional usability, fun, intrinsic motivation, engagement, sensuality, pleasure with products, apparent usability, etc.

One of the most often cited views on the hedonic side of usability is presented by Logan (1994) and Logan et al. (1994), who divide usability into behavioral and emotional dimensions. The emotional dimensions of product usability attract the consumer's attention. Emotional personal relation according to Holman is essential to understanding consumer behavior in relation to different products. Pleasure with products is defined by Jordan (1997a) as "the emotional and hedonic benefits associated with products". He considers pleasure with products to be described by four dimensions:

- **Physio-p** is related to touching and holding products
- **Social-p** refers to social relations and communication enabled by the product
- **Psycho-p** is achieved when products assist users in accomplishing tasks
- **Ideo-p** refers to the values products and their use represent

He does not consider pleasure to be a dimension of usability, but an aspect of product experience and product evaluation that goes beyond usability. Products must to be usable. Pleasure is the determinant criterion after usability problems have been solved. The dimensions of pleasure are: security, assurance confidence, pride, excitement, and satisfaction. They are related with the following product properties: functionality, usability, aesthetics, performance and reliability (Jordan and Servas 1995). It seems that pleasure has quite functional origins on the product level.

This pleurability that has been enhanced and emphasized by interaction design trend. Where the interactive products usually targeting the senses basically developing using situation and user experience, in addition to adding more functions and values to the design.

3. Furniture as interactive product

The interactive furniture is a growing design trend, where so many tries has been made in several types of use and context. Although, most of it is no more than conceptual designs, but the indicators pointing to vast diversity of applications. That in addition to the understanding of consumer purchasing behavior, his paradox of choice, non-ethical marketing strategies and weakness of market regulations, clarify the need to a guideline or an ethical practical framework helping designers to participate effectively saving the future of environment. The following examples shows some fields of future furniture applications.

Mood chair (Fig. 4): was designed by Aether and Hemera . It's a chair that reacts to behavior. The chair changes color according to the colors that its sensors perceive from the environment and from its users. It transforms them into lighting effects. It does that with its translucent units and embedded LEDs, sensors and software. (<https://www.homedit.com/6-interactive-furniture-designs-with-unique-features/>)



(Fig. 4) Mood chair

Lighting bench (Fig. 5): Interactive benches were created by NunoErin specifically for the new Mississippi Children's Museum. The benches are made of translucent resin, sensors and LEDs and they are part of the interactive installation that teaches children about electrical storms. The hidden network of sensors detects electrical charges within the human body and responds with displays of flickering light. (<https://www.homedit.com/6-interactive-furniture-designs-with-unique-features/>)



(Fig. 5) Lighting bench

Ucreate digital art tables (Fig. 6): Ucreate digital art tables offer creative and imaginative children's games with a playful modern design. The games provide an outlet for self-expression, collaboration, and discovery and are simply fun to play! When not in use, screensavers display cheerful animations that extend the spirit of play and can be customized with branded images or logos. (<http://nunoerin.com/gallery/>)



(Fig. 6) Ucreate digital art tables

The Interactive Pod Beds (Fig. 7): Interactive multimedia bed automatically knows your favorite music, your travel schedule and your television preferences. It contains:

- An internet connection, either through Wi-Fi or Ethernet.
- An entire audio-visual system with an HD video projector and 5-point audio system that includes drivers mounted under the mattress—hook up an iPod, watch cable TV or DVDs or stream media online.
- Mechanized curtains and a drop-down screen that can be used to completely enclose the bed.
- LED lighting under, above and around the bed—you can turn on a reading light, create your own light show or set a sensual mood.

And all of that is controlled by two retractable 17-inch touch screen monitors.

(<http://design.spotcoolstuff.com/travel/network-of-beds/somnus-neu>)



(Fig. 7) The Interactive Pod Beds

Brandt Aion Kitchen (Fig. 8): It's designed to serve both as an air recycling unit and a kitchen, the Aion comes complete with a sink and an electric stove. Once you're done cooking, the contraption closes and waters the series of plants that line it. Finally, it create= soap from the plant extracts and uses it alongside the water to wash the sink and surfaces.



(Fig. 8) Brandt Aion Kitchen

The Digital Harbour (Fig. 9): The Digital Harbour is an urban development project with outdoor furniture. Benefitting from free high-speed WI-FI connection, this harbour features durable swivel chairs made from concrete, with mini tables joint to the chairs - perfect for using a smartphone, tablet, laptop or book. A touch screen on the side of the structure provides city information and news for those without any devices. (<http://www.jcdecaux.com/blog/intelligent-interactive-designer-street-furniture-mathieu-lehanneur>)



(Fig. 9) The Digital Harbour

Based on the previous examples, we can divide furniture in general into 2 types:

- a. Personal: characterized with the ability of personalization, deep effect of fashion, style, identity and self-image. Also, high cost and obsolescence rate.
- b. Public: characterized with clearness and simplicity to work along wide range of users. More practical, slight effect of fashion, style, identity and nearly no self-image. And most of all, low cost and obsolescence rate in comparison to using rates.

Of course, we can categorize each type into more detailed categories. But in relation to the aim of this paper, these 2 types is enough to clarify the differences in applications and values. the applications that could be controlled wisely through design ethics and economics, and the values that reflects directly on environment through the rete of obsolescence and the environmental cost too.

4. Discussion

In other work, we have argued the reputation of sustainability in relation with UX, design strategies in relation with marketing plans, and the emotional factors affect purchasing decision. Where the aesthetics is a decisive factor for consumers when making procurement decisions and the environmental performance remains at a late stage in the process of assessing purchase alternatives. Interactive furniture should be a central focus of the research and practice of interactive design.

Some researchers tried to investigate the importance of interactive design obsolescence phenomena in general. For example, Blevins describing the rubric for understanding particular interaction design cases. Where terms like forms of use, reuse, and disposal from the perspective of sustainability is useful for understanding the environmental impact of interaction design in terms of use of physical materials and resources, however prompted by the use of digital materials.

In this paper we first tried to explain what we mean by Interactive furniture to suggest a framework for understanding how sustainability can be considered as a factor in design with interactive technologies, considering furniture as an obsolescence product.

We here argue the importance of understanding the relationship between usability, sustainability and interactive technologies and the future of furniture design. Considering the biases that reveal the intellectual preferences for studying products in culture. Which can be summarized by three abstract concepts: cultural, interpretive and pragmatic.

Referring to furniture as an interactive product that is on the way to be a part of the culture of the future, the structural and semiotic aspects offer a more sophisticated theoretical ensemble for capturing meaning-making processes with products. Developed principally through the writings of Saussure and Lévi-Strauss, this work highlighted how cultural products are relationally ordered, symbolic, and how they can be understood.

The personalization ability that designers use to make interactive products meaningful, more related to the consumer, and the ways in which products are relocated through a range of psycho-cultural strategies, to be continuously able to be shaped and re-shaped by their human users through the interplay of physical and symbolic manipulation. Personalized interactive technology promising new possibilities for making furniture more comfortable, interesting, multifunctional, interactive and informative and more fun, where every little detail will matter.

It is not sufficient to depend on consumer behavior toward either purchasing or reusing. Where the preference is much stronger for newer products. Aspects of style, status, identity and self-image affect such preferences as much as issues of form and function (Blevis, 2007). It is quite true, that in process to design an interactive furniture we have first to know who the user is, gender, age, health status, and the using context. But from the perspective of this paper, the context is the main focus. Where the type and number of users is the main aspects to evaluate the actual value of the product. In another words, it is the prejudgment variables that we can rely on it, making our decision about the value of the new design. Therefore, the future of interactive furniture must be preplanned to achieve and fulfill every possible opportunities, enhancing human life better way without harming the environment. Through developing designers awareness toward UX, behavior and the code of ethics. All under umbrella of organizing regulations to control non-ethical marketing strategies.

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