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Kurzzusammenfassung.“Smart products”, die mit einer „built in flexibility“ ausgestattet sind, bilden die Produkte der Zukunft. Sie bestehen aus Komponenten der Informations- und Kommunikationstechnologie und sind besser als herkömmliche Produkte in der Lage, sich je nach Funktionszweck individuell auf unterschiedliche Leistungsanforderungen anzupassen. Sie verfügen über die besondere produktinhärente Fähigkeit, den Nutzer bei der Findung des kundenindividuellen Leistungsergebnisses zu unterstützen. Eines der besten Beispiele ist das IPad. Das IPad wird von den Nutzern unterschiedlich verwendet, nämlich z.B. nur als eBook oder sogar als Musikinstrument. Mit unserer Untersuchung gingen wir der Frage auf den Grund, inwieweit derartige Produkte den Nutzer bei diesen Gestaltungsaufgaben (design tasks) behilflich sind. Hierzu entwickelten wir zunächst ein theoretisches Modell zur Funktionszweckentwicklung (usegeneration), das wir schließlich auf zwei smart products, die mit built in flexibility ausgestattet sind, übertrugen: den ADIDAS OneLaufsschuh und eine App für Mobilfunktelefone namens EMOTIO. Sämtliche Ergebnisse zeigten auf, dass Gestaltungsaufgaben den Nutzern zugewiesen werden. Auf Grundlage dieser Ergebnisse wurden Managementimplikationen berücksichtigt, wonach Produkte effizienter die Gestaltungsbereitschaft der Nutzer fördern könnten.

Abstract. The recent applications of information and communication technology (ICT) in consumer products uncovered a promising form of user-product interaction. Such technology indeed succeeded to empower users to self-design the use of their products. We callthem“*smart products with built in flexibility*” (SPBF).A popularexample is the iPad. With the software tools, certain users are today able to createa different usage experience for each of their individual needs.Many firms view this phenomenon as an opportunity to be tap as it should yield a higher level of satisfaction among users. In this paper,we attempted to better understand how this new class of products assist users in the design process of their uses. To reach this goal, we developed, by making use of modern design theories, atheoretical framework for use generation and applied iton two types of SPBF namelythe ADIDAS One running shoes and an app for mobile phone called EMOTIO. Withthe results, we coulddetermine the nature of design mechanisms carried out by such products so as thedesign tasksassigned to users. Following this, we finallycould consider managerial implications so that these productsbetter help fostering the design capabilities of each individual user for the generation of uses.

Introduction

Smart products with built in flexibility (SPBF) have the exceptional abilities that usersfully endorse the role of designers of their own products with regard to the uses. That is, with SPBF, firms no longer perceive uses as a functional specification of a product that should be absolutely defined by them, but instead delegate deliberately the task of looking for a use of a product to users [1].Today,the success of SPBF is still anecdotic[2].However, taking the tremendous successes of iPad as an example to follow, more and more firms try todevelop SPBF[1].Notably, users engage in co-creation not only of multimedia products (e.g., video game, PC, software) but also of others (e.g., toys, car, house). So, SPBF is of high interest for a high number of firms.

At the moment, research on SPBF is still emerging in the field of new product development or engineering design. Whilein ergonomic, the importance of a proper user interface is mentioned [4], in industrial design, the focus is on the new opportunities that SPBF offer to designers [5].On the contrary, in the business press, the increasing relevance of SPBF is undeniable. Many firmshave, further, opted for developing specialized laboratories to conduct research on SPBF [6].

In this paper,using our theoretical framework for use generationon the two kinds of smart products with built in flexibility, we diligently look at the mechanisms related to the user-product interaction when users design uses. This enable us to identify the nature of design mechanisms carried out by such products so as thedesign tasksassigned to users. Following this, we propose managerial implicationsin order to better promoteusers´ abilities to design.

Our paper is organized as follow. We first present a literature review on smart products with built-in flexibility. Then, we describe the theoretical framework for use generation. Next, our findings are summarized. In the last part, we discuss the implications and limits of our study so as suggest further research.

Literature Review

A new class of smart products generating uses.SPBF can be described as being an ordinary product equip with a set of complementary design tools that enables users to self-design the use they want via (1) a trial and error process and (2) an immediate feedback on the creation outcome [3]. These sets are composed of ICT components in a form of sensors, software, microchips and other advanced electronics. With these technology, all SPBF share the abilities to collect, process, produce information and so somehow to think by themselves. Let´s take theKinect for instance. With the design toolkit integrated into the product, Kinect is nowadays used to assist surgeons in their practices orto scan in the 3D Printing process.

A promising form of product- user interaction. Along with this, it uncovers a new form of product- user interaction which succeeded to unsettle two established ones in the NPD literature. We, here, refer to the interactions with products where users have either no or the entire design efforts to make. With regard to the first one, it has long been assumed that users are only passive recipients with no design skills. While firms design the new product so as its set of associated uses, users are merely here to buy the object that possibly fit them the most. In this framing, users diligently interact with the product strictly based on instructions manual [7]. In contrast, with the second one, it was revealed in a more recent literature that users rather than firms are active designers. It is especially embodied in the lead user theory [8]. In this regard, there is a class of very skillful users that develop new products in certain product domains that fit them better. A renowned case is the skate board [9]. Users thought about disassembling a kind of roller skate so as hammered the wheels onto boards and the skateboard was originated. In view of that, with SPBF like the Kinect, it is evident that there is a new form of product - user interaction. Shortly, we describe it as follow: firms design a product thatcarry out design activities for use generation, launch it on the market and users –with various design skills - take the role of active designers of their own products for uses. Subsequently, the design effort is neither fully carried out by firms nor by users but instead by both.Accordingly, the value of SPBF is capturedin its ability to generate uses.

SPBF for personalization or for innovation. There are two types of SPBF. There is a complex one with a rather large solution space which is not operated easily by users. Thereby, such SPBF necessitates a technical understanding prior to its use. So, only skillful users are able to utilize it.Example is, for instance, the open source software Apache [10].In contrast, the other offers a small solution space and simply enables users to passively select a few pre-defined options from lists. Its benefit, though, is that all users – regardless of their design capabilities – can use it. In this regard, whereas it generates uses, the latest definitely focuses on optimization [3].

In summary, we observe that the two kinds of SPBF describe above offer value so as potential drawbacks. What is still missing, though, is what are the design mechanisms involved in these new forms of product – user interaction that permit users either to optimize or innovate?It is particularly interesting to understand thisbecause, as they are consumer products i.e. purchased products, SPBF should above all foster the users´ design abilities to design the uses for innovation or optimization.To understand this better,we made use of modern design theories and developed accordingly a theoretical framework for use generation that we applied on two SPBF.

Our theoretical framework for the design of uses

To address this question, we mainly made use of C-K theory[11]. With this contemporary methodology, it enables us to develop a theoretical framework that helpunderstand the use generation carried by SPBF.

So, we here represent a product (a smart product as well as a basic product)as having a design space that carryactions and values. In this framing, to use a product consist in addressing a certain value through a given action (Action > Value). With the iPad for instance, some actions are to turn it on, to download apps, to take pictures whereas the value to perceive it as a mobile library or as a book.So, the iPad could be used as follow: to open an apprelated to music (action) in order to listen to the favorite song (value).

In certain products, use is a functional specification [12].That is, they bring with it a series of uses obvious for users. A prime example is the Swiss Knife which offers a full set of actions with it associated values. That is, it is equipped for every eventuality of uses a user may have in outdoors activities i.e. using the knife to make a sandwich, utilizing the bottle opener to open a drink or a tin opener for can etc. Thereby, do not need high design capabilities to employ it. In the worst case scenario, there is the instruction manuals delivered with the product. The latest enables users who are not familiar with the object to get enough knowledgeto utilize it. In contrast, for other products like the iPad, users do not know intuitively how to use them as it is not prepared in advance by firms.iPad is just a platform where one can create of download apps. So, this requires a design effort from the users to understand how to use the products.Take, for instance, the Missing object designed by Konstantin Grcic. It is composed of a solid block of oak with two excavated handles. By looking at it,there are noevident uses i.e. set of actions associated with values stay as this was purposely undefined by the designer.Konstantin Grcic in fact intended to stimulate users to explore the usesof the product. This was made possible due to its familiar and meaningful form. So, such product does not carry many connections between values and actions.So, users do not know immediately what are the values behind the product or what are the actions. Therefore, it requires a competent user, who are able to view an action so as a value and create a connection between the two to create a use.

Model proposition for the design of uses. With the above examples, we suggest now to go further and model each product with their design space as carrying evidently uses i.e. meetings of actions and values but within a larger actions and values spaces. Within these spaces, it permits users to design the uses they want. So, our model is finally represented as seen in Figure 1. There are the actions space represented by a circle and the values space represented by a second one.Further, there are the meetings actions->values located within the interaction between the actions and the values spaces.

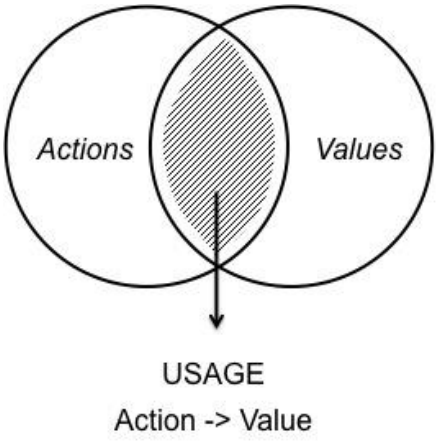

Figure 1: Basic model for the design of uses

Then, this interaction which gathers among all, every possibilities of a product´s uses made openly available by the firms is proposed to be called, referring to [13], the *apparent solution space* whereas the total amount of actions and values offered by the product is suggested to be labelled the *attainable solution space*. Please see Figure 2 for a better understanding.

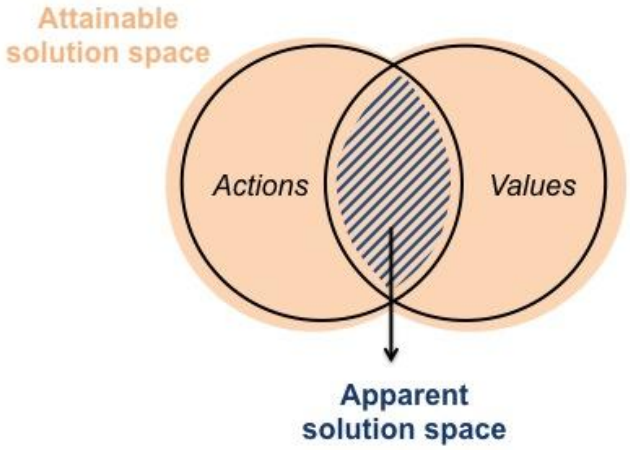

Figure 2: Basic model represented with the attainable and apparent solution space

Applying this model to our two previous products´ examples, when the apparent solution space is very large within the attainable solution space, products like the Swiss army knife are represented. Most of the uses are made evident to the users and the exploration of new uses are on the other hand hardly supported by the products. In short, users know exactly how to act on the product in order to obtain a specific value. Making use of the CK theory [11], we propose to model these products as *strongly conjunctives*. That is, they directly organize the connection between a project of use a user would express in the form of value proposal and their functionalities i.e. a set of actions. Of course, in such cases, in order to design the uses, users would have to possess the piece of knowledge that would enable them to realize the uses offered by products. For instance, it might be, in the case of the knife, knowledge on how to use the can opener of the Swiss knife to open a tin.

In contrast, when the apparent solution space is extremely thin so as compare to the rest of the attainable solution space, products like the Missing object are represented. That is, these objects barely carry uses that are evident to users but offer a large attainable solution space empowering users to explore new uses. In this regard, users have to look at the actions and the values spaces so as to create some connections between actions/values. By exploiting the CK theory[11].we suggest to model these products as strongly disjunctives. Even though they propose users an actions and values space, such products never organize the connections between both spaces. In other words, they propose no uses previously known by users. When interacting with these products, users are then stimulated to formulate projects of unknown uses. As seen earlier, this requires a high design effort. That is, not only the users have to define unknown uses but also realize them. By doing so,

users need to learn and gain knowledge which are not offered by the products in order to create new uses. In Figure 3 is shown an illustration of it.

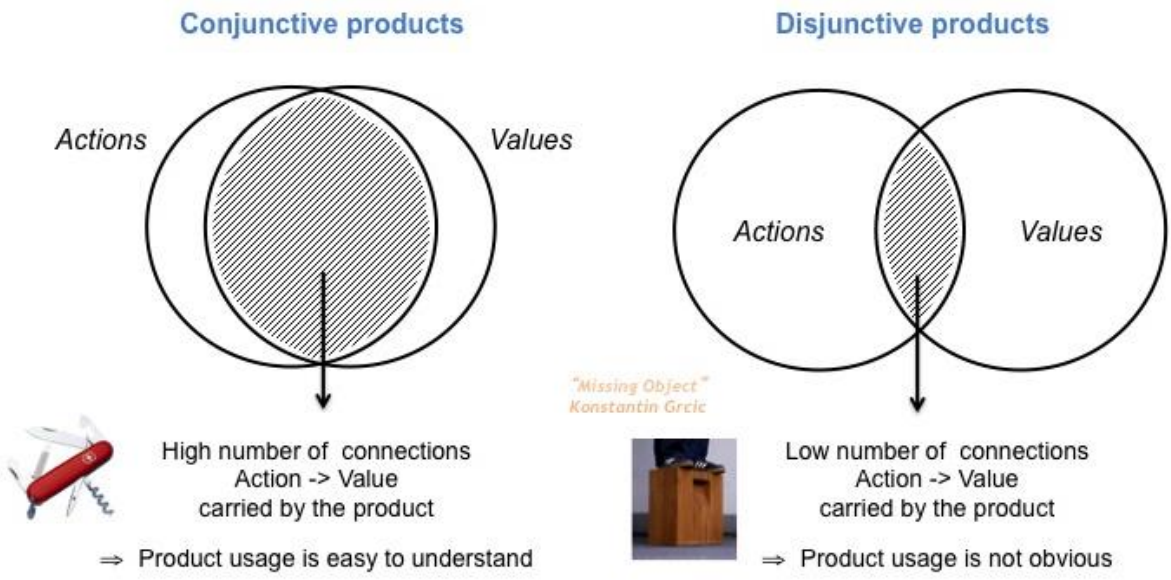

Figure 3: Modelling conjunctive and disjunctive products

In any cases, however, when new uses are designed, the apparent solution space are subsequently enlarged for the product of the user originating those uses. Basically, the idea is that users explore the attainable solution space offered by the product, generate new connections between actions and values and accordingly widen the interaction between the actions and values spaces. Further, in the specific case that this new use is shared with other users, via online communities for instance, then the apparent solution space is consequently extended for all of them.

So, here, we aimed at, by making an effort of modeling two observed products in term of uses generation, developing a theoretical framework for the design of uses.

Impacts of the built in flexibility on use generation

In this section, the theoretical framework introduced earlier for the present study is applied on two smart products with built in flexibility. There are the ADIDAS One running shoes and the EMOTIO app. The ADIDAS One running shoes is built in flexibility via a sensor, a microprocessor, a user interface and other advanced electronics. With this ICT system embedded into the shoes, the product is capable - after analyzing in real time users' running style and terrain - of modifying instantaneously the compression characteristics of its heel pad. Additionally, via a very small console with a simple plus and minus button, the shoes enable users to select up to five factory setting gradients whether users prefer a soft or firm ride. With regard to EMOTIO, it is an app for android phone which creates the built in flexibility. Via the app´s user interface, users are able to visualize all features present in their phone i.e. SMS, camera, light, calling function and simply combine features together with drag and drop. By doing so, the idea is that users are empowered to create the ultimate features that fit them perfectly. For instance, one of the applications that we created was to connect the mobile phone´s calendar with the rest of the features. With such adjustment, the phone could calculate automatically the required transit time from the user´s position to the meeting's location and inform via pop up notification when it is time to go. The pivotal idea of EMOTIO is that users should besupported to create new features.

The Adidas One Running shoes – built in flexibility for optimization of uses. Overall, running shoes are modelled as conjunctive products. Whatever value proposal a user suggests; such products spontaneously offer back an associated action. Rare are the possibilities left in the exploration of new uses. Focusing on the ADIDAS One running shoes, with the built in flexibility, the products

subsequently offer new actions and values. To press the button plus and minus of the small console is the most obvious action whereas to adjust the sneakers for a soft or firm ride is the most evident value. Both action and values are actually obviously connected with each other i.e. pressing minus means soft ride whereas plus signifies hard ride. Accordingly, even though with the built in flexibility, the sneakers remain conjunctive. What changes, however, is that the original attainable and apparent solution spaces of the product are enlarged (see Figure 4).

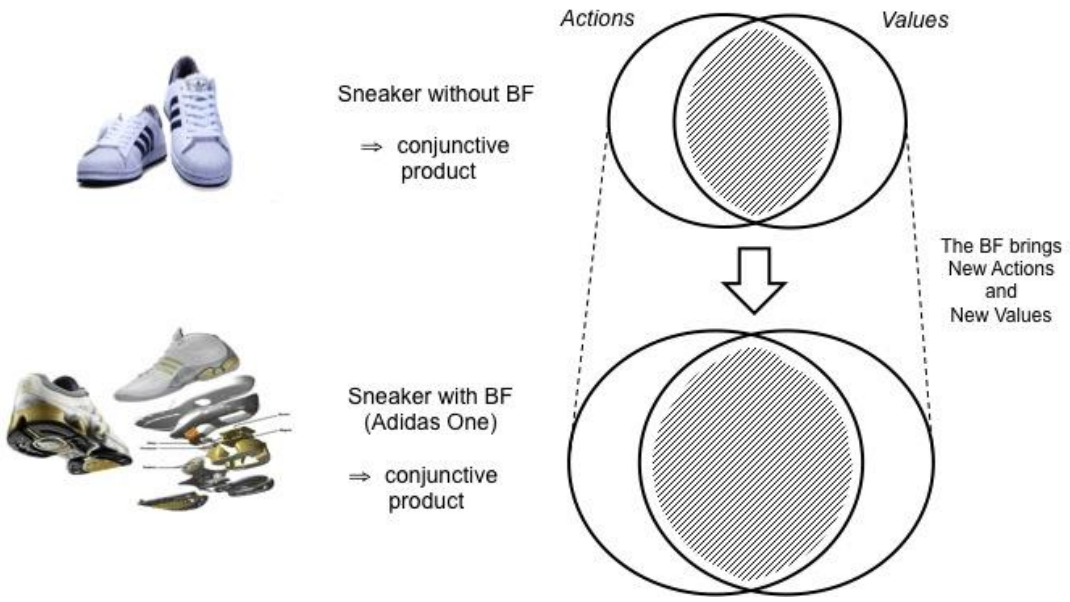

Figure 4: Smart products with built in flexibility for optimization

With such type of built in flexibility, the conjunctive aspect of the product is preserved. When looking at the model above, the true value of this built in flexibility is indeed captured in empowering users with the ability to further optimize their products to their latest preferences. In the case of the ADIDAS One running shoes, users have now the opportunity to adjust their sneakers to their running style and terrain. However, this task might not be as simple as it may appear. Indeed, users must possess the piece of knowledge that would support their capacities to realize uses proposed by the products. While this was evident for all users with the Swiss army knife, it is less obvious with the ADIDAS One running shoes as users are unfamiliar with them. So, instructions manuals have to be provided along with the products.

The EMOTIOapp – BF for innovation. Smart phones are rather conjunctive products. Users know how to act on such products in order to obtain a specific value. In this regard, the prominent set of actions are to call, to text, to set up the alarm clock and the respectively associated values consist of contacting someone or waking up on time. In spite of this, for a large minority of users, smart phones act as a medium that helps generating a large range of new uses. Certain users indeed develop new apps so new uses with their smart phones. Accordingly, the product leaves some free space within the attainable solution space for use generation. In the case of the EMOTIO app, once uploaded in the mobile phone, the app subsequently proposes new actions and new values to their users. That is, one of the new actionsis to combine features of the mobile phones via drag and drop whereas the value is to adapt the phone´s functionalities to the users´ way of living like to combine the agenda with the silence mode so as the GPS in order to not be disturb at work. Yet, the app never offers the obvious connections between actions and values. Users have to think about a value and attempt to create the connectionon their own. The user of EMOTIO has to envision a value while trying out several combinations of features together. Referring to our model, it means that the size of the attainable solution space increases with EMOTIO but not of the apparent solution space. In this regard, via this app, a smartphone with such built in flexibility turns into a disjunctive product (see Figure 5).

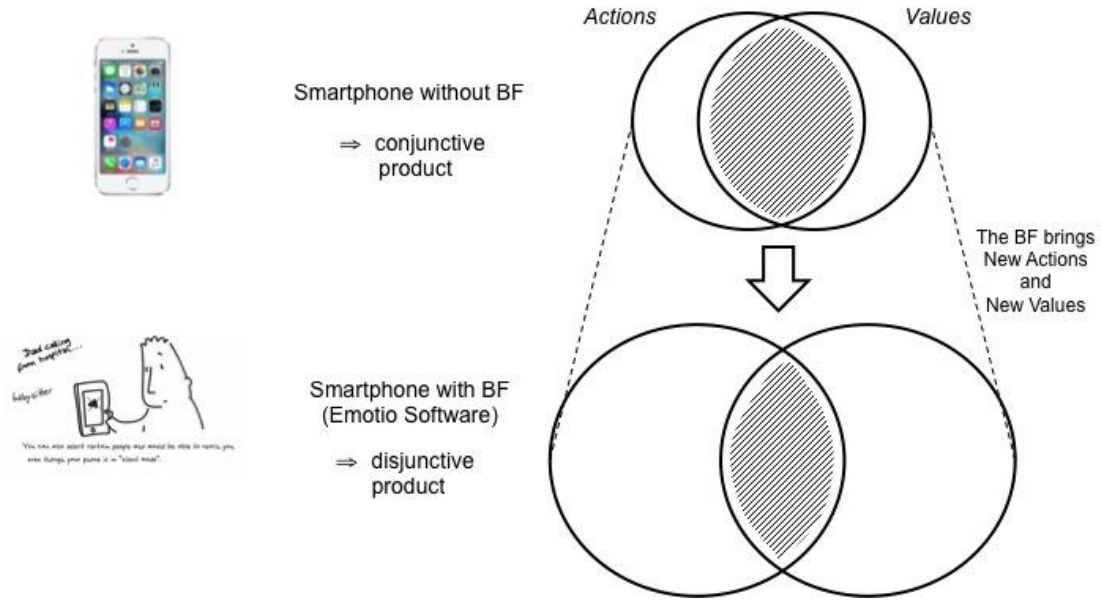

Figure 5: Smart products in built in flexibility for innovation

With this type of built in flexibility, products with conjunctive aspects become then extremely disjunctives. This built in flexibility suddenly empowers users with the ability to entirely review the uses of their products and then redesign new uses that fit them better. That is, they offer users new possibilities of actions and new possibilities of value creation but without specifying the connections between the two spaces. What is particularly apparent with EMOTIO is that, users would most certainly have to make an intensive effort to self-design uses. By having a look at the model above, the discrepancy between the size of the attainable solution space and the size of the apparent solution space is the explanation of it. Obviously, it means that users who have already very good knowledge on smart products have an advantage. They are more incline to create connections between the different features of their mobile phones as they know very well their products. This may as well explain why 64% of the open source software usersare passive ones[10]. Most of the users often lack knowledge that support their capacities to realize the unknown uses imagined.

Findings and discussion

In this paper, we aimed at understanding how SPBF empower users to self-design the uses they want. More explicitly, we focused on the interactions between users and SPBF when users design their uses. To reach this goal, we did not follow the classical approaches employed in the new product development field. Instead, we made use of contemporary design theories as they offer a new perspective to study this problematic. We especially employed this methodology to establish a novel theoretical framework for use generation. With this, it enabled us, first of all, to uncover that the design of uses is a design activity that firms should start to focus onwithin the NPD process. By having a look at the findings, it is particularly evident with products equipped with ICT like SPBF. They possess capabilities like adaptability, human interaction, smartness, etc. that enable easily users to generate uses they want. Many examples confirm it in the market place i.e. Raspberry Pie, Twitter, Kinect or iPad or Lego Mindstorms. Accordingly, we believe, as the phenomenon of smart products intensifies with the time, that research in NPD so as industries which often ignored it, should catch up with it.

Then, with an effort of modelling SPBF, we stressed the fact that the design of uses is based on a representation of users that have design capacities that are proper to them. We here refer to the conjunctive and disjunctive capacities that each individual user activates when designing with SPBF. As a reminder, we described the conjunctive capacities as being the users´ abilities to realize projects of uses offered by the products and disjunctive capacities as referring to the ones that formulate projects of unknown uses. Those are fueled by knowledge and skill of users. Besides, we

think that it offers a more realistic representation of users than the ones introduced in the literature. After all, according to [14], it is an evidence that all users naturally repurpose the use of their products.

But, most of all, we showed that the two kinds of SPBF present in the market place possess mechanisms of use design that are characteristics of them. With regards to SPBF like the ADIDAS One, they directly set up the connection between a project of use a user would express in a form of value proposal and their functionalities i.e. a set of actions. So, although they do not allow use exploration for new uses, they closely guide users in their pace of optimizing their uses. That is, they are characterized as being extremely conjunctive and thereby, users are uniquely delegated with the task of realizing the uses offered by the products. In contrast, SPBF like EMOTIO rely on a different mechanism for use generation. They carry a set of actions so as values but never provide the connections between both. They are identified as being disjunctive. It signifies that they stimulate users to formulate projects of unknown uses but do not provide them with guidance. Therefore, users have to make an intensive effort in order to innovate and so create new uses.

Finally, with our models, we evidently captured the value creation that offer the built in flexibility of SPBF. Despite differences, we observed that either the ADIDAS One or EMOTIO have a potential added value so as compare to the same products but with no built in flexibility. They basically propose new actions and new values. Further, we as well strengthen previous research on value creation [15] by making explicit a few conditions under which such findings hold. As explained beforehand, there is a one kind of SPBF i.e. the ADIDAS one that create value by focusing on the individualization of a few aspects of the ordinary products. Our findings showed that one of the prerequisite conditions is that they have to be conjunctive. The other kind like EMOTIO generate value when empowering users to innovate. We observed that to permit this, such SPBF have to be disjunctive.

Either one or another, with the SPBF that are in the market place, it is still a fact that it is not ideal to foster the design capabilities to innovate or co-design. We underline the fact that it is especially problematic as they are purchased products. Presently,whereas some restricts them, the others can target only skillful users. Relying onour findings, we may be able then to extend this to the next level by conceptualizing a SPFB that truly encourage users´ abilities to design. Ideally, they are disjunctives so as conjunctives. That is, they encourage users to formulate projects of unknown uses so as guide them better in their pace of realizing these uses. To reach this goal, we proposemanagerial implications. We especially suggest not only to design the SPBF but also the use generation process behind it. We propose to do it by focusing on support and supervision forms that can go along with the products and change entirely the use generation process for each individual users. Obviously, literature showed us that user to user assistance or creative online communities that accompany the products can be a solution [16]. In a same line of research, among all, we suggest, according to recent studies on the fixation effects in neuroscience [17] to provide with the SPBF products that are disjunctives, a few innovative examples of uses with instructions manuals so as creative communities. These products would then become disjunctive but with some conjunctive aspects. Mostly, it means that it would enable users with various design capacities to exploit more of the possibilities of unknown uses available in the SPBF so as acquire knowledge on how to realize them. Referring to theliterature [e.g., 13; 17], this should increase the chance that SPBF address all kind of users so as having later on active designers for use creation. In details, these examples would indeed help to enhance the creativity of each individual users so as increase their knowledge and skills on the product itself. Other opportunities for further research can be derived from the above suggestions.

Further, certainly, we have limitations in our study. The main one is that the representations of the values and actions spaces of each product used were not entirely precise. It would have been obviously better to adjust the size of each circles based on the true numbers of actions and values carry by the products. It would certainly mean that both circles for the ADIDAS one would be smaller than the both ones for EMOTIO.However, we were not able to obtain precisely this information and opted for a standard version of the circles. We believe, yet, that it does not change

our findings but instead can be another possibility for further research i.e. focus on the size of the solution spaces in addition to the design mechanisms.

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