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Develop habit-forming products based on the Axiomatic Design Theory

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Abstract

It is every manufacturer's desire to drive its target customers to form a long-term habit of regularly using its product. Previous studies indicate that the habit of using a certain product can indeed by formed in a systemic manner, once the right sequence is followed. Against such a background, an existing habit-forming product model, namely the Hook Model, is reviewed with respect to its key components of trigger, action, reward, and investment. Essences of the Hook Model, together with its missing pieces, are reformulated, repositioned, and resynthesized based on the Axiomatic Design Theory. It results in an adapted Axiomatic Design process, which is intended to develop the habit-forming products. The step-by-step design process is explained, and an illustrate example is presented.

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Keywords: Habit; Design Method; Axiomatic Design

1. Introduction

Habit means a tendency of repeatedly performing a certain behavior that is difficult, if not impossible, to be resisted by a person or organization. Habit-driven behaviors consume a great amount of most people's daily lives, and they are performed with little, if any at all, consciousness, thinking and reasoning [1]. Furthermore, a large number of routine decisions within organizations are made based on various underlining institutional habits [1]. To date, many efforts have been devoted to investigating how and in what ways a positive/desirable habit can be formed from scratch, as well as how and in what ways a negative/undesirable habit can be corrected, if not replaced by another good habit. The habit-forming process has been explored in the context of, for example, addictive drug/alcohol usage [2], organizational management [3], software design [4], etc. It has been repeatedly validated that, following a closed loop of trigger-action-reward [1], a desirable habit can indeed by "imposed" on a person, team, and even organization. The above outlines the background against which this design study is conducted.

A vast majority of, if not all, habits are associated with a certain product. From manufacturer's perspective, there are a number of benefits of driving its target customers to develop a regular, long-term, and self-reinforcing habit of using its product. On one hand, the more frequently a product is used as a result of habit, the more likely that the customers would develop a special dependency on the product, which could eventually evolve towards brand loyalty to the manufacturer's other products. On the other hand, in particular for those Internet-based product/service, the frequent usage leads to Internet traffic, and hence creating advertising opportunities for the online business. In addition, as the global economy becomes increasingly over-supplied and the competition continues to intensify in many industry sectors, gradually, the key of market success hinges on whether and to what extent a product can successfully win customers' time. In other words, the more time customers are willing to spend on a particular product, the more likely that the product will distinguish itself and hence win the market competition in the long term. As it happens, ordinary people spend more than 40% of his/her time on various habit-driven behaviors [1].

To date, very few research efforts have been devoted to investigating the distinguishing features of those habit-forming products. Even fewer efforts have been invested to develop sound design methodologies, which can guide

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designing the habit-forming products in a systemic manner. Therefore, we are motivated to prescribe a systemic design process to guide creation of the habit-forming products, based on a synergy of validated habit studies and sound design methodologies. The rest of this paper is organized as following. Section 2 reviews a habit-forming product model, namely the Hook Model, which is a descriptive model that characterizes the typical habit-forming product. Section 3 reviews relevant studies of the Axiomatic Design Theory. Section 4 presents an adapted Axiomatic Design process that is intended to guide creation and evaluation of the habit-forming products. Section 5 draws conclusions and outlines future works.

2. Hook Model of habit-forming products

2.1. Overview of Hook Model

The Hook Model was developed by Nir Eyal based on his rich knowledge and abundant observations obtained from the online advertising and video-gaming industries [4]. The model consists of four sequential but interrelated phases:

1) Trigger phase: an external and/or internal trigger informs the user what to do next and how to act accordingly.
2) Action phase: the user conducts a behavior according to the information provided by the trigger.
3) Reward phase: the user receives variable rewards as a result of conducting the above triggered behavior.
4) Investment phase: as the user's time and efforts of using the product increases, so does the values of the product to the user.

Above all, any habit begins with a trigger, which means a specific piece of information that explicitly "tells the user what to do next" [4]. Generally speaking, there are two types of triggers: external trigger and internal trigger. The former is a part-of or contained-in the product. Figure 2 illustrates some real-world examples of external triggers, for instance, "check engine light", "play video button", "mailbox icon", "one-click purchase button", etc. In contrast, internal trigger refers to the inexplicit information that resides in the user's mind in the form of, for example, memory, reflection, association, heuristics, and most importantly emotion. Unlike the external trigger that is visible, the internal trigger is invisible. Compared to the external triggers, internal trigger plays a more important role of inspiring, driving the users to develop a long-term habit of using a product. It is discovered that those negative emotions play an even more important role of forming the long-term habits [4]. Examples of negative emotions include: uncertainty, loneliness, fear, confusion, depression, feeling of lost, feeling of being excluded, etc. It is often observed that customers attempt to get rid of the negative emotions by using a certain product. For example, with little if any thinking, people tend to check their Facebook page (i.e., an online social networking site) when feeling lonely, to search information through Google (i.e., an online search engine) when feeling uncertain, to use Wikipedia (i.e., an online encyclopedia service) when feeling unknown.

Fig.1. Real-world examples of external triggers

Next, the user conducts a behavior as a response of being triggered. For example, people can conveniently play a video on YouTube by clicking the "play" button (i.e., a certain kind of external trigger), check Facebook when they feeling bored (i.e., a particular type of internal trigger), etc. According to the Fogg Behavior Model [5], the likelihood that a behavior will be conducted is influenced by three necessary factors: motivation, ability, and trigger. Motivation means the extent to which the user desires to perform an action, ability measures the degree of difficulty/convenience associated with the user's ability to perform the action, and finally a trigger (either internal or external trigger) must be present to remind/activate the action. Unlike motivation that is by nature personal, subjective, and hence difficult to manipulate, designers could and should always endeavor to enhance the user's ability to perform an action by making the product simpler to use. Any action occurs and only occurs when the three components are put together, no more and no less. In other words, the user conducts a certain behavior if and only if there are sufficient motivation, adequate ability, and an active trigger. Note that, the action phase is an important transitional phase. On one hand, a behavior is directly activated by a trigger and systemically guided by the information contained in or associated with the trigger. On the other hand, the action is purposefully performed by the users by an anticipation of variable rewards.

Next, after a certain behavior is performed as instructed by the trigger, the user must be rewarded accordingly. The key of designing a reward is to make it variable every time the product is used. In other words, depending on different efforts and time devoted by the user to performing the triggered behavior, the amounts of reward should vary every time. According to the Hook Model, various rewards can be classified into three categories: reward of tribe, reward of hunt, and reward of self [4]. Firstly, "reward of tribe" refers to the sense of satisfaction gained as a result of effectively communicating, collaborating, and networking with other users, for example, through social networking sites (Facebook), video sharing sites (YouTube), photo sharing applications (Instagram), etc. Secondly, "reward of hunt" means the sense of satisfaction the users gain from searching, publishing, and exploring desirable resources, for instance, by means of search engine (e.g., Google), blogging service (e.g., Twitter), and online encyclopedia (e.g., Wikipedia). Thirdly, "reward of self" refers to the sense of satisfaction coming from successfully solving a problem, completing an unfinished task, enhancing a competency, etc., for example, thorough playing video games, responding emails, and learning online (e.g., Massive Open Online Courseware).

Finally, a habit-forming product is equipped with a self-reinforcing mechanism. In other words, the more the product is being used, the more values it automatically generates to the user. For example, the more followers a Twitter user successfully attracts, the broader the user is able to spread his/her influences; the wider connections a LinkedIn user develops, the more career development opportunities he/she could explore; the richer content a Google user searches, the deeper the search engine understands the user's searching patterns based on the big-data technology [4]; the more products an online shopper purchases from Amazon, the more accurately online retailers can recommend relevant products to the user based on the recommendation algorithm [6].

2.2. Missing pieces of the Hook Model

From the perspective of engineering design, we identified multiple critical issues that are not addressed by the above Hook Model. Firstly, it ignores the interactions and hence the dependency relationships among different habits of the same user. It has been indicated by previous studies that various habits indeed interact with and impact on each other [1]. As a result, for example, it is often observed that a series of "good" habits tend to aggregate together on the same person or organization, and there exists a keystone habit that leads to the formation of many related habits in a chain-reacting manner [1].

Secondly, the Hook Model failed to consider the different abstraction levels of designing a certain habit-forming product. Various habits are associated with different levels of abstraction and frequency of circling. Therefore, they must be organized according to a certain design structure that accommodates diverse levels of abstraction, such as the hierarchical structure. For example, the general habit of using Facebook can be decomposed into two more specific habits of (1) updating personal statues and (2) browsing other's statues, and the two specific habits occur at different frequencies. For example, it is often observed that the majority of Facebook users browse other's statues much more frequently than they update their own status.

Last but not least, the Hook Model is primarily a descriptive model. In other words, although it clearly pictures what a habit-forming product looks like in practice, the model cannot be directly applied to guide creating a new habit-forming product from scratch. In order to transform the Hook Model from a descriptive model to a prescriptive methodology, its essences (i.e., key notions, step-step process, and the closed loop) must be reinterpreted, repositioned, and restructured based upon a theoretically sound and practically viable design theory.

That being said above, these missing pieces of the Hook Model can be framed as unique research questions, which can be addressed by the sound design methodologies such as the Axiomatic Design.

3. Review of Axiomatic Design Theory (ADT)

3.1. Axiomatic Design Theory

Axiomatic Design Theory (ADT) was developed by Nam Suh at the MIT. It is one of the most well-known, extensively studied, and widely applied design theories [7]. Despite Suh's strong mechanical engineering background, ADT was developed to be a completely domain-independent design methodology, the applications of which can be found in diverse product categories such as mechanical systems [8], manufacturing systems [9], software systems [10], etc. In this study, ADT serves as the theoretical framework, upon which, the above reviewed habit-forming process is accommodated, situated, and adapted.

ADT is characterized by the key notions of "domain", "hierarchy", "zigzagging", and "axioms". Firstly, domain was a new notion introduced by ADT in order to categorize various design entities of different kinds. According to ADT, any design entity can be classified into one of the four fundamental domains, namely customer domain, functional domain, physical domain, and process domain. The design entity accommodated in each domain is customer need (CN), functional requirement (FR), design parameter (DP), and process variable (PV), respectively. Secondly, within each domain, a hierarchy is built to organize the same kind of design entities according to their different abstraction levels. Together, the domain-hierarchy structure guides designers to move forward along two orthogonal thinking directions, leading to a two dimensional design pathway. In the author's previous works, some logic-based theoretical foundations were found to justify the roles played by such a two-dimensional structure in guiding the systemic human reasoning [11]. Thirdly, ADT prescribes a zigzagging process to map different types of design entities across adjacent domains, and to decompose the same type of design entities into further details through neighboring abstraction layers, in tandem. Lastly, ADT suggests two design axioms, namely the Independence Axiom and the Information Axiom, in order to evaluate, compare different concepts. The Independence Axiom suggests that FRs should be formulated independent of each other, and as much as possible, such an independent state should be maintained when DPs are proposed as means to satisfy the FRs. The Information Axiom suggests that, among those functionally uncoupled or decoupled concepts, the most physically certain concept is the best concept.

The ADT framework can be strategically leveraged to reinforce the above explained Hook Model. First, the notion of domain can be used to categorize, in a much more explicit way, the various entities included in the Hook Model. Secondly, the notion of hierarchy suggests that those inter-related habits should be positioned at different abstraction levels and developed progressively. Thirdly, the zigzagging process can be used to navigate the decomposition of a general habit loop into multiple smaller habit loops, while maintaining the corresponding relationships between different design entities with diverse levels of abstraction. Finally, the

Independent Axiom is useful to manage the dependence relationships among different habit loops, so that every habit can be formed, following its own frequency accordingly. More details of how the Hook Model is integrated with ADT will be explained in Section 4.

3.2. Complexity Theory

Entering the 21st Century, against the background that more and more complex systems emerged due to unwise design decisions, Suh further developed a Complexity Theory based on the fundamental principles of ADT [12]. Unlike ADT that is intended to guide the creation of new systems, the Complexity Theory is tailored to improve those existing systems by making them less complex to produce, use, and maintain. Suh classified various design complexities into two general categories: time-dependent complexity and time-independent complexity. The former is further divided into imaginary complexity and real complexity, whereas the latter is classified as combinatorial complexity and periodical complexity. According to Lu and Suh [13], the overall difficulty of a product is determined by two factors: inborn complication and acquired complexity. As much as possible, designers must focus on eliminating those acquired complexities by making more informed design decisions.

Suh's Complexity Theory has two major implications on the habit-forming product design. Firstly, as much as possible, a system should be simplified (or made less complex), so that the user's ability of employing the product to perform a certain behavior becomes enhanced. In that regards, Suh's Complexity Theory prescribes some tailored strategies of dealing with different kinds of design complexity. Secondly, depending on the nature of different habits, the frequency of their loops should also be clearly differentiated. For example, the frequency of washing a car should, by no means, be equivalent to the frequency of servicing the same car. And this is only possible when the Independence Axiom is strictly followed.

4. Develop habit-forming products upon Axiomatic Design

4.1. Integration of Hook Model and Axiomatic Design

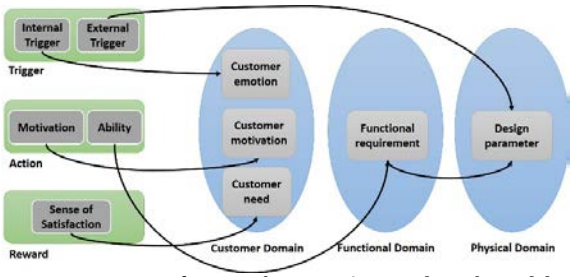

Fig.2. Mapping of notions between ADT and Hook Model

As illustrated by Fig.2, our theoretical investigation is to map these key notions of the Hook Model (i.e., trigger, action, reward, investment) to those of the Axiomatic Design Theory (i.e., domain, hierarchy, axiom, and zigzagging), and to adapt the axiomatic design process respectively based on the characteristics of the habit-forming product.

The first question to address is how to accurately interpret the notion of "trigger", situated in the ADT framework. On one hand, since the internal trigger essentially concerns with a user's emotion, it is most suitable to be placed within the customer domain. In recent years, emotion-based and/or emotion-driven design is drawing increasing attentions in the engineering design community. On the other hand, because the external trigger is a visible feature attached to the product, it is most appropriate to be treated as a particular kind of DP.

Next, the notion of "action" needs to be interpreted based on the ADT framework. According to the definition of action in the Hook Model, it seems that it should be classified into the customer domain, because it refers to a certain customer behavior that is activated by the trigger. Nevertheless, not only a customer can perform certain behaviors, but also a product has its unique behaviors as well. The notion of action is divided into two entities: functional requirements and product behavior. The former is placed in the functional domain, whereas the latter is placed in the physical domain, respectively. In the past, the Function-Behavior-Structure (FBS) model has thoroughly explained the fundamental distinction between function and behavior [14].

Next, in practice, rewards often appear in different forms such as monetary reward, recognition reward, emotional rewards, etc. Based on ADT and the Hook Model, it is most appropriate to define reward as a particular sense of achievement when a certain customer need becomes satisfied. Therefore, it should be classified as a special kind of customer attribute (CA). Suggested by the Hook Model, those higher level human needs in the Maslow's Hierarchy [15], for example, self-actualization (i.e., creativity, problem solving, acceptance of facts, etc.) and esteem (i.e., confidence, achievement, respect of others, respect by others), are more likely to result in the forming of long-term habits.

Finally, since ADT did not explicitly prescribe how and in what ways the users interact with the product, towards a self-reinforcing mechanism of generating and accumulating values, the authors choose to exclude the notion of "investment" in the proposed new method.

Table 1 summarizes the key technologies used in the proposed new process together with their originality and correspondence in the Hook Model and IDT. Note that, based on the set theory in mathematics, the customer domain is formulated as a whole set that contains the subsets of "customer emotion", "customer motivation" and "customer need", which are all different kinds of customer attributes. Similarly, the physical domain is regarded as another set that includes the subsets of "design parameter", "external trigger", and "parameter behavior". Note that, the entities within every subset should be organized using separate design structure (e.g., the hierarchical structure).

Table 1. Key notions and their correspondence in the Hook Model and IDT

Terminology in the new method	ADT	Hook Model
Customer emotion (CE)	CA	Internal trigger
Customer motivation (CM)	CA	Motivation
Customer need (CN)	CA	Reward
Functional requirement (FR)	FR	Ability
Design parameter (DP)	DP	External trigger
Parameter trigger (PT)	DP	External trigger
Parameter behavior (PB)	DP	Ability

4.2. Process of developing habit-forming products

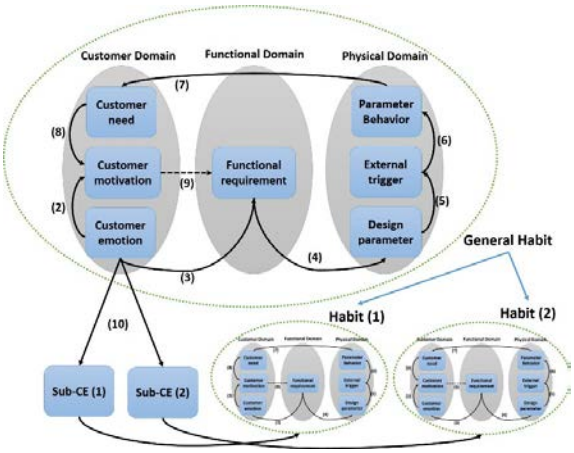

Fig.3. Design habit-forming product based on ADT

Figure 3 illustrates the step-by-step process of how to systemically create a habit-forming product based on Axiomatic Design.

Step (1): a particular customer emotion (CE) is identified in terms of, for example, fear, anxiety, confusion, uncertainty, embarrassment, exclusion, etc. As much as possible, the designer should concentrate on those negative emotions than positive ones, since the former is more powerful to drive towards forming a habit. In practice, the CEs can be identified by means of a variety of design methods, for example, surveys, ethnographic study, interview, focus group, etc.

Step (2): the designer estimates the level of customer motivation (CM) that is associated with the identified CE. By definition, CM measures the degree of willingness that the user desires to deal with, if not eliminate, the negative CE.

Step (3): a set of functional requirements (FR) are proposed, as means, to address the previously identified CE. In other words, a specific engineering design problem is framed in order to ease the negative CE. It should be noted that, system range of the formulated FRs is determined by the CM estimated in step (2). Specifically, the higher the CM is, the wider the system range is, and vice versa. In other words, the more motivated customers are to address the CE, the lower requirements it imposes to the product's functions.

Step (4): a set of design parameters (DPs) are proposed, as physical means, to satisfy the above formulated FRs. In this regard, the designer must strictly follow the Independence Axioms prescribed by ADT to generate and select the uncoupled or decoupled concepts, so that separate habit loops can be created and maintained.

Step (5): a visible external trigger is added to the DP.

Step (6): the user activates a certain physical behavior of the DP through the external trigger.

Step (7): the designer validates whether and to what extent the above triggered behavior satisfies a certain customer need (CN) in the customer domain. The sense of satisfaction serves as the mental reward that drives the user to repeatedly trigger the behavior.

Step (8): the designer evaluates how and in what ways the satisfaction of the CN increases or decreases the CM.

Step (9): based on the above evaluation result, the designer may adjust the FR's system range accordingly. For example, if the CM goes lower, the FR's system range goes higher.

Step (10): the designer decomposes the general CE into more specific sub-CEs. For each sub-CE, the above steps are repeated in order to build smaller habit loops. During the process, the Independence Axiom must be strictly complied with, so that the sub-habits can be developed, managed, and maintained independent of each other.

4.3. An illustrative example

Instagram is one of the most popular online photo-sharing services, which is installed on numerous smart devices (e.g., smartphones and tables). Once installed, it is commonly observed that the Instagram users often develop a habit of regularly using the service over time. In this paper, Instagram is used as an illustrative example to showcase how to use the above proposed process in practice. Figure 4 illustrates the full hierarchies of customer emotion, functional requirement, design parameters, and customer needs. Each hierarchy consists of three abstraction levels. One general habit (i.e., using Instagram) and two sub-habits (i.e., posting photos and checking activities) are analyzed.

In terms of the general habit of "using Instagram", the original CE is identified to be the emotion of interacting and socializing with others. Such a CE in the customer domain is first mapped to the FR of "to share photos" in the functional domain. The DP is proposed to be an APP service that is installed on smart devices. Next, an external trigger (i.e., an APP icon) is added to the desktop of smartphones. By clicking the icon, the user can easily activate the APP. As a result of using Instagram, the general CN of "esteem" becomes satisfied.

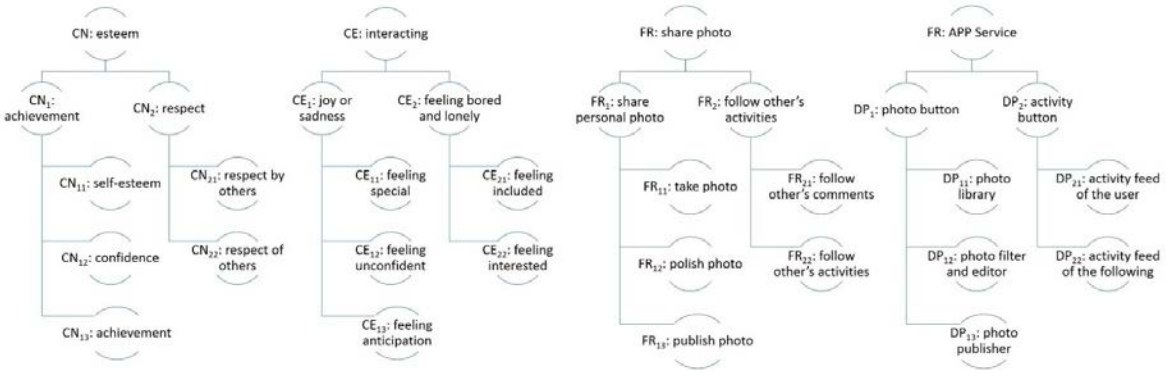

Fig.4. Design hierarchies of the illustrative example

With respect to the sub-habit of "posting photos", its original CE_1 is the emotion of joy or sadness, and its corresponding FR is to share photos. Specifically, the Instagram users are more likely to share their own photos in the occasions when they feel very happy or unhappy. Note that, FR_1 can be further decomposed into FR_{11} (i.e., to take photo), FR_{12} (i.e., to polish photo), and FR_{13} (i.e., to publish photo), and each sub-FR corresponds to a specific sub-CE and is realized by means of a particular sub-DP. For example, the user employs the filter (DP_{12}) to polish the photo (FR_{12}) for the reason of feeling unconfident (CE_{12}). In regards to the sub-habit of "checking other's activities", the original CE_2 is recognized to be the emotion of feeling bored, which can be eased by following other's activities (i.e., FR_2), by means of an activity button (i.e., DP_2).

5. Conclusion and future works

This paper presents our initial efforts of adapting the Axiomatic Design Theory (ADT) in order to develop the habit-forming product. Specifically, the key notions (i.e., trigger, action, reward, and investment) of the Hook Model are mapped to that of ADT, and the design process of ADT is adapted to accommodate the closed loop of habit-forming. A structured design process is prescribed, following which, the designers can systemically create, evaluate, and select new concepts of habit-forming products.

With respect to future works, effectiveness of the proposed process will be validated. Specifically, a more detailed case study will be conducted. In addition, a controlled experiment will be conducted to compare applicability of the proposed process on forming a new habit and changing an existing habit. Based on the findings of the case study and controlled experiment, the proposed method will be further modified respectively. Last but not least, the process will be utilized to reengineer an entry level design course at the University of New South Wales. Specifically, it will be systemically followed to redesign the course in order to accommodate the new pedagogy of flipped classroom, which has been proven effective to enhance the teaching and/or learning of design. In that regard, for the sake of a smooth transition from the traditional lecturing-centered teaching to the new interaction-focused learning, a new learning habit must be formed in a systemic manner.

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