Design for Smart Trash Cans

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Abstract

Technology offers the potential to make life easier and more enjoyable; each new technology provides increased benefits. It also increases the complexities of use. If the products using these functionality are not designed properly, it leads to frustration with the technology. With emerging technologies like Internet of Things, there are many new products which can solve the urban city problems using technology. In this paper, I want to focus on the importance of human centered design of these smart products. The affordance of these smart products are different from the traditional products, which they have replaced. A trash can for example, affordance of a traditional trash can is for the people to dispose waste, a smart trash can on the other hand, can notify the cleaning agency, that it is full and needs maintenance. Technology has increased the affordance of the trash can. The technology that simplifies life by providing more functions in each device can also complicate life by making the device harder to learn and harder to use. This, in words of author Donald Norman, is the paradox of technology and the challenge for the designer. Interaction design works successfully with several design principles that are widely implemented and used in the community of designers. Urban designers and architects who are building these smart products should answer to similar questions, as the interaction designers in Human Computer Interaction. A focus on the quality and enjoyment of the total experience, of these smart products will make our cities more livable and user-friendly.

Keywords: user centered design, Smart devices, Internet of Things, emotions and design, appropriateness, seven stages of action, visceral level of user expectations, behavioral level of user expectations, reflective level of user expectations, Trash can, Big Belly.

Design for Smart Trash Cans

With advance in technology, today we have all kinds of smart devices. The city administrators and planners want to use the smart city devices that contribute to solving or alleviating urban issues, such as traffic congestion and CO_2 emissions, with intelligent monitoring systems on streets poles and Internet of Things/big data analytics technologies. Solutions have been developed for management of waste and recycling that use wireless network monitoring technology and intelligent, real-time, solar-powered waste collection systems to cope with city governments' serious problem of ever-increasing garbage. Smart trash cans solve the problem of city governance agencies, but it should not result in frustration for the citizens.

Let us take a simple example from our lives, it is a sunny day and we go out for a walk and ice cream. It's fun to sit on a chair, on a sunny day and enjoy your favorite ice cream. When the time comes for disposing the ice-cream cups, spoons and tissue papers, what do we do? We look for a trash can. What if we find one but are not comfortable using it? What if it is difficult to reach for the kids? Most of us would probably collect the trash in a paper bag and try to find a more usable or throw it after we reach home. Some might dispose the trash around or on the trash cans, rather than touching them and going through an uncomfortable interaction.

Design requires cooperative effort from multiple disciplines. Donald Norman operates with seven action stages for designing products and three level of emotional processing for evaluating them, in his book, *The design everyday objects*. With the help of this model, the designers can come up with designs that have positive impact on its users. In this paper I will discuss the usability of smart trash can, Big Bellies. The city governance agencies have been replacing the wire basket trash cans with the smart and costly Big Bellies.

THE PROBLEM

Big Belly is a solar powered, rubbish-compacting bin, manufactured by Big Belly Solar for use in public spaces such as parks, beaches, amusement parks, and universities. Its smart waste and recycling system combines the power of cloud computing systems for monitoring waste conditions, with connected solar-powered, compacting waste and recycling stations. Big Belly is one of the companies which was listed in Cool Vendors in Smart City Applications and Solutions, 2015 by Gartner. Gartner highlighted that Big Belly trash cans include solar trash compactors, and companion recycling bins and kiosks, connected via wireless network monitoring and management software that provides real-time and historical information to managers or workers to plan waste collection routes and pickups. Trash compactors are designed to increase capacity by five times, and the ability to configure these waste and recycling stations helps meet the demand of different waste streams at each location. This is done by determining the right capacity or size, based on historical data, in turn, ensuring collection frequency is shrunk by 70% to 80%.

The collection, logistics, efficiency and notification system (CLEAN) management console is the key component of the Bigbelly system. CLEAN offers users the appropriate tools and data in accomplishing the smart waste and recycling management solution. Bigbelly provides installation, cleaning, maintenance and monitoring of the entire system for a monthly fee.

Figure 1(a) & Figure1 (b), showing the big belly trash cans, installed at public places.

The problem is with the design of the trash can, from the point of view of general public. One has to use hands to pull open the trash-in slot, with only the help of the handle. I refer to it as touch-to-use model. The handle could be greasy or a carrier of infections as it is public trash can and everyone uses the handle to access it. The design of the trash can forces the citizens to dirty their hands to dispose the waste.

Figure 2, the trash-in slot of the big belly

If anyone try to use it anyway, it further poses more issues, while disposing the trash. After pulling the handle to open it, the user then has to place the trash carefully, through the sleek opening as shown in the picture, onto the tray which has sharp edges and release the handle. We can find similar reactions from people across the web, about these big belly trash cans.

DISCUSSION

In his book, the design of everyday things, Donald Norman discusses a framework for understanding human action and guiding design. It is called the seven stages of action cycle. According to the framework, every need for a product or innovation arises from a need to satisfy a user goal in the before designing any product or service, the designers should identify the goal

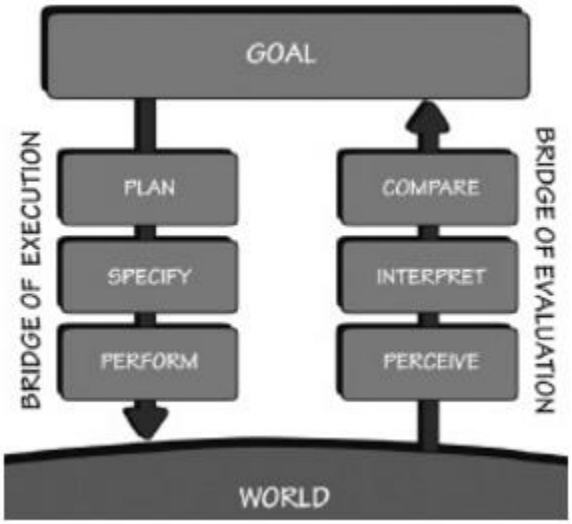

Figure 3, re-created from Donald Norman's book, the design of everyday things.

of users

Once the goal is identified, the product enters the bridge of execution. This consists of stages like planning the design, specifying the actions needed to use the design and then finally performing the action which we specified in the previous stage. Once it is released to the world, which means the audience, we can evaluate it. For evaluating we first perceive the reaction, then interpret it. The last stage is comparison, comparison to what was actually wanted from the product.

In the big belly case, the technology in hand, Internet of Things, has expanded its goal. The goals of this product are to provide an easy garbage disposal mechanism for the public trash cans. The designers planned that they had to build a trash can which eases the job of city maintenance agencies and then probably specified, the use of internet of things, compactors, solar panel and so on. At the end of the bridge of execution, the designers came up with the design shown below.

Big belly does an excellent design for making life easier for the maintenance agencies.

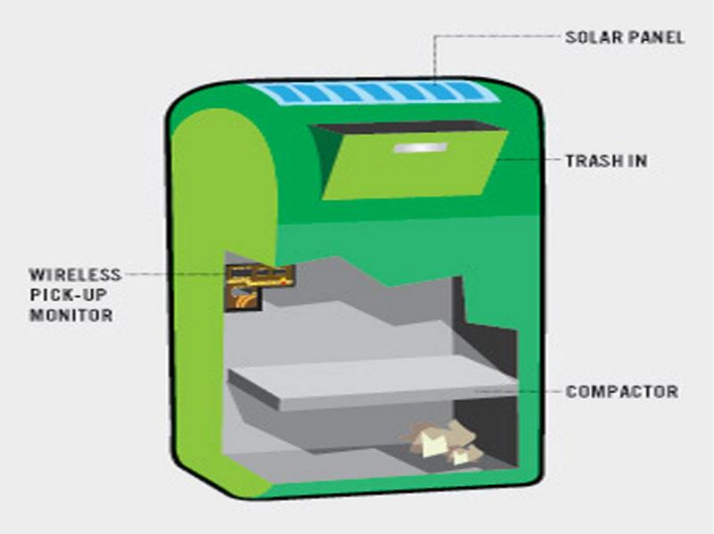

Figure 4, Courtesy of scienceofthetime.com

Coming to the bridge of evaluation, Donald Norman also specifies, the different levels of processing, which helps in evaluating a product. These levels of processing are actually the levels of emotional satisfaction of a user. The framework evaluates a design on these three levels of user's emotional satisfaction.

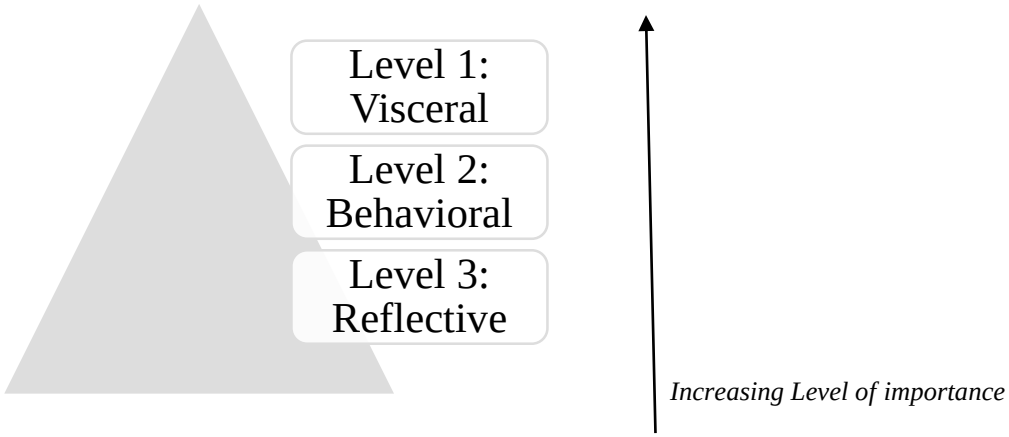

Figure 5, Levels of user's emotions processing of a design, as pointed out by Donald Norman

The first level is visceral feedback or visceral emotions. It is the least level of importance. The second is behavioral feedback, which has high level of importance and not as high as the

next level, the reflective level. I will explain these emotional level as we go along, the bridge of evaluation.

And this is how these emotions fit in the seven stages of the action cycle.

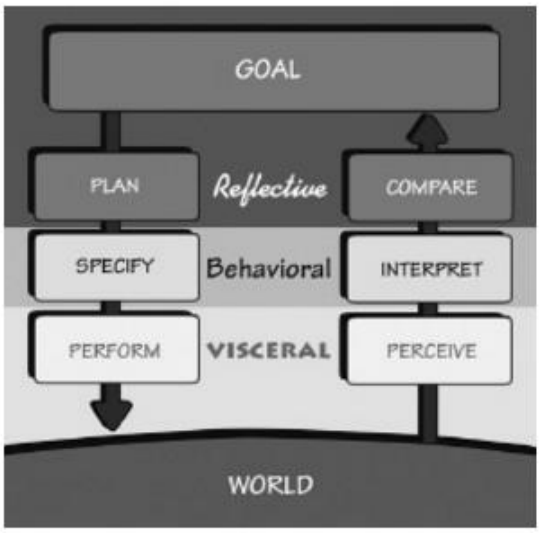

Figure 6, re-created from Donald Norman's book, the design of everyday things

Visceral response concerns itself with the appearance of the product. It is the response that comes out spontaneously. It comes naturally to people and is influenced by the culture of the region. On evaluation, the big belly succeeds at the visceral response of the user it is intended for, the people of the city. This is because of its covered design, it keeps the garbage from escaping, keeps flies and rodents at bay. Its covered design also prevents foul smell and prevents garbage from escaping. It makes the city look clean and litter free. Visceral response is the most basic level of processing.

The next level of processing, for a human mind is behavioral. Behavioral response has to do with the pleasure and effectiveness of the product. It is all about how useful the product is, the appearance doesn't really matter. The big belly fails at this level. It failed because of the touch-to –use design of the product. For using the trash can, people have to open the trash in slot by their

hands, which has been used by many people, probably with sticky hands or probably by someone with communicable disease.

It fails at the next level of processing that is reflective response. This is the level where conscious decision making takes place. It is about the meaning of things, the personal remembrance something evokes. Big belly fails at this level, as the users, who have used it once, decide not to use it again because of the discomfort they had last time. These three emotions guide the users, while interacting with products. Especially the once which concerns hygiene and well-being.

As behavioral level of experience is the most important of all the levels. It also affects the Reflective behavior. So, I will discuss the behavioral level and also explain why big belly fails the behavioral level. Behavioral level is about the experience with a product.

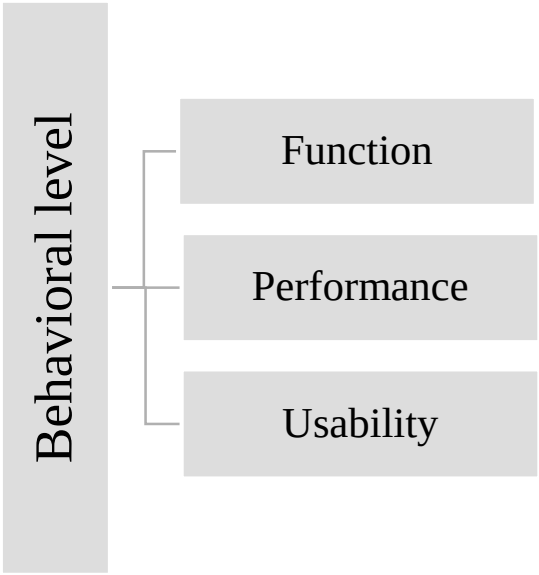

Figure 7, showing the different facets of behavioral level of processing.

In his book, emotional design, Donald Norman, says that there are 3 facets of experience that defines the behavioral response of an individual. The 3 facets are, function, performance and usability. Function represents what the product is meant to do. Performance is how well the

product performs the desired function. Usability is the ease with which the user can perform the function. If any of these three facets are inadequate, the product is of no use.

In the case of the smart trash can, big belly, for the intended user group, the function is to dispose garbage. If we pull the handle of the trash can, yes it will serve the purpose. But as we discussed earlier, many users may not be comfortable touching the handle and the design does not provide any other alternative to use itself. Let us assume that a user, open the trash can to dispose the trash. So we can say, it does get the function facet of experience correct.

In the performance facet, when the user opens the trash in slot, he is provided with a tray and a sleek 30 degree opening. The user has to place all the garbage onto the tray through this 30 degree slot. The interior has sharp edges also, so there are chances that someone might get hurt, like I did.

Figure 8, the trash-in slot of big belly.

It actually makes the user think how to fill in the trash, especially if they have a lot to dispose. So, it fails in the performance facet. Coming to the last facet of behavioral experience, usability. Many users can be uncomfortable on using the handle to dispose the waste. It could be due to cultural reasons, OCD or just hygiene reasons that can make people skeptical about

touching the handle to dispose waste. One situation could be if the user has both the hands occupied. The trash can does not present any other alternate for use. It also fails in the usability facet due to these reasons.

After behavioral level comes the reflective level of emotions. It is the level of personal satisfaction and consciousness. Previous experiences is what determines this level of emotion. As specified earlier the product also fails to satisfy this level.

A user who has used to trash can earlier and knows that he/she has to think how to fit the trash in the sleek 30 degree slot or the maybe they had bruised themselves the last time they disposed trash. A past experience of touching a sticky or wet handle can also make users refrain from using it the next time.

Appropriateness .So far we have discussed about the three level of user expectations and how they are different from each other. We also discussed how the smart product in question fails at the levels and why it fails so.

A successful design has to excel at all three levels. This can be achieved if the designers concentrate on the appropriateness of the product. Appropriateness can be determined by three factors. These factors will help the designers, build products that could be successful at all three levels of responses. Designs should be appropriate to the audience, the location and the purpose.

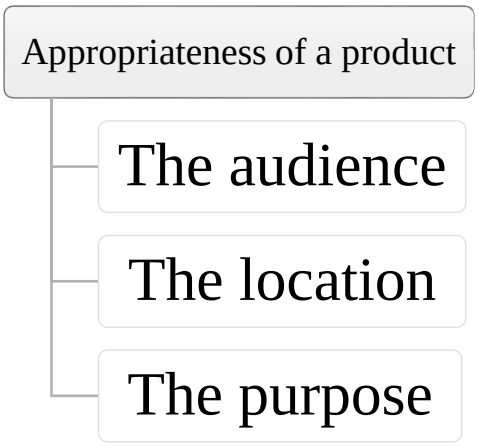

Figure 9, the three levels of appropriateness, as explained by Donald Norman.

A trash can has a large audience, which ranges from kids to elderly. Kids are also a large user base for this product. The location of the handle makes it impossible for kids to use. The audience all sort of people with or without communicable diseases and mental health. So it is not advisable, to put a handle for usage.

The above design is supposed to be for public places. Littering is against the basic norms of society, so it will be used by everybody.

The purpose of a trash can is to help users dispose waste and not dirty their hands. The handle being the sole interaction, it may dirty ones hands. The user may not be able to use it, if both the hands are occupied. Also, if in case the handle is broken, the trash can is not usable at all. The trash can will also be useless if the size of the trash, if greater than the 30 degree slot it provides.

Usability and practicality are as important an aspect of design, as are the manufacturing and marketing of a product. For satisfying the levels of user experience, sometimes the designers have to trade off a few aspects of industrial designs. It is not sufficient for a product to be good visceral level and not perform what it is intended to do. The designers have to decide a middle path to satisfy all three experience levels at least at some levels.

My Idea. I have tried to create an alternate design for the smart trash cans, using the above explained models. I have built my example based on the big belly model. The main reason for the trash can, to fail on the behavioral and reflective level of interaction is its touch to use handle model. I researched on various aspects, by which I could get rid of the handle and still maintain the other salient features of this smart product. The first option was to replace the handle with motion sensors. It removes the handle and will be easy to use for kids and adults alike. It also gets rid of the 30 degree slot and those sharp edges, which can improve the behavioral and consequently the reflective level of experience.

But, if I try to judge the appropriateness, it looks like a bad option. It is supposed to be located in public place, so there could be bugs and flies. Motion sensors are highly susceptible. If a bug passes near it, it may open to that as well.

The second option, which in my opinion fits in is the pedal operated version. It is similar to what everyone generally has at home. Using the pedal is better than using hands. A pedal operated trash will change the industrial design to some extent, but will improve the behavioral and reflective level of user experience. This is a decision which designers have to make, while designing a product, which aspect to trade off for satisfying which aspect. If a product is designed to be used by people, the product should be designed keeping their usability in mind.

There are many other aspects of the pedal operated design, which has to be taken care.

Like the location, public places can be accessed at night and so can be the trash cans. The pedal, the trash –in slot and instructions should include bright colored reflectors for visibility at night.

As the trash in slot is now operated by feet, the outward motion of the trash-in compartment can shock the users. This will affect the experience of the user with the product.

This will result in failure of reflective level of emotional satisfaction of the user. So, the slot should swing inwards rather than outwards. The trash –in slot can also be replaced with shutter or a lid.

As the user base is large, ranging from kids to adults, the pedal should be large enough to accommodate all shoe sizes or feet sizes.

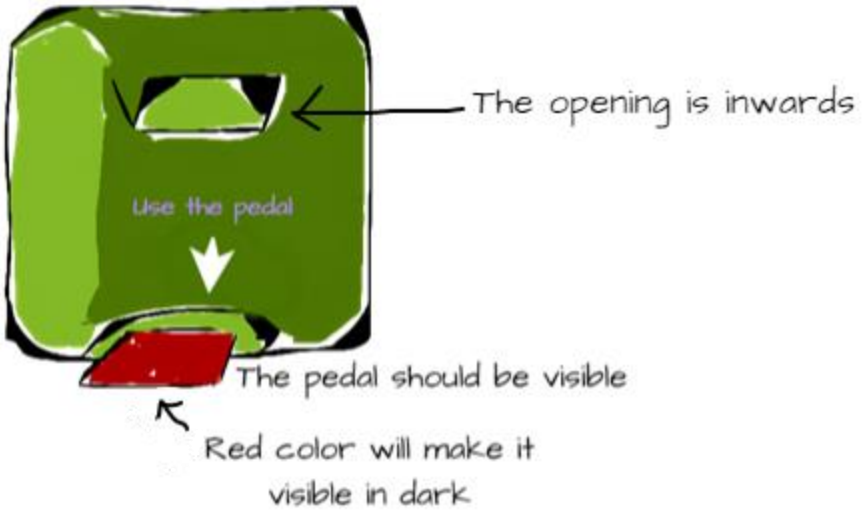

Figure 10, my idea of a smart trash can.

I have designed this with user- centered design approach, this will change many things on the industrial design of this product.

General design, of any product, which is targeting a large user base should be user – centered. Especially when the design is of a trash can or any other object which is the basic need of the society.

For visceral design, the principles of visceral design are wired in the minds of the users, which are consistent for everyone. To satisfy this level, culture of that particular place and preferences of the people should be taken into consideration while designing. Especially, when a product is designed for public use.

Visceral is about initial reactions of the users, so it can be studied easily and modifications can be made in the next version, if any.

Behavioral design, is the most important one as it concerns whether the product can perform its function or not. Even if the product is simple and average on the visceral level, if it performs well, it satisfies this criteria.

In case of smart trash cans or any other smart appliance for that matter, this criteria is not as easy as it seems. Smart appliances have increased the affordance of the traditional products. This is why the behavior of these appliances are different from the traditional once. But designers have to remember that the mental model of user is still the same. The purpose of the trash can is still the same. The conceptual model of the designer should be able to align the design of the smart appliances with the mental model of the users.

If a smart trash can satisfies the previous the visceral and the behavioral levels of processing, it should satisfy the reflective level of processing as well.

CONCLUSION

By understanding the different levels of emotional satisfaction of human beings, and by weighing the appropriateness of a product, as done in the example above, designers should develop user experience oriented smart objects. It is essential that the designers, don't just assume that users will understand or manage on their own. The change in technology, takes away the visual clues that the users are used to. The design of a product should accommodate this change. As happened in the case of the trash can, traditional trash cans have an opening on top, it is visual clue, and a smart trash can has to remain closed at all times, due to technical specifications. This results in a different behavior from the users, which are influenced by their emotions, as mentioned in the discussion. Designers should keep this change in mind, and

develop a user-centered design, may be trading off some of the industrial design specifications. As technology advances and starts replacing important aspect of our day to day life, it is important that these products using new technology, be measured on the same scale as other interactive products, especially the ones which intend to make the cities smart and demand user interaction. Engineers emphasize on developing the concepts and specifications of a smart product. While focusing to optimize the functionality of the product, the aesthetics of form and the quality of interaction take the back seat. Till now, most of the mechanical or industrial products followed activity –centered approach, or maybe they were designed mostly by engineers and not user experience professionals. This cannot carry on in the arena of smart machines like smart trash cans. If these intelligent things are designed to be used by people, they should be designed keeping them in mind. Inability to use the trash can, can result in frustration, leading the citizens to not use it at all. If we want to build smart cities, the smart devices should be designed with a user-centered design approach and not activity –centered approach.

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