Measuring a product's usefulness

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Abstract
This paper explains how a product's usefulness is defined and measured. Many aspects of consumer product assessments relative to usefulness are conducted sub-consciously and this process is closely examined. A product's usefulness can be evaluated by measuring its advantages over alternative solutions based on specific criteria associated with fundamental needs. When multiple criteria are involved, different weights are assigned to each. We conclude that aspects of a product's usefulness, connected with sub-conscious human decision making processes, can be a major factor in predicting product acceptance and rejection rates.

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H.5.2. User Interface: Evaluation Methodology

1. Introduction

Designing a product is a complex task. When integrated with considerations of manufacturing, legal matters, legacy issues, competitors, safety, and time to market, creating a successful product is a daunting endeavor. A major factor of success is product usefulness, which is the capacity to bring practical advantages to users. On the other hand, failure is guaranteed if a product is not useful.

Practical advantages include saving time and errors, saving energy, increasing sensation of security, and improving quality of the outcome.

There is a subtle but meaningful distinction that needs to be made between usefulness and ease of use. This distinction is delineated in the example of a user preferring a relatively more difficult to use MP3 player, because some required functions such as recording audio or radio are not available in an easier to use version. Thus, an object easy to use could be useless if it does not include required functionalities for a given activity [1].

The context of use reveals usefulness. For example, a piece of rock in itself has no intrinsic usefulness. However, the rock can be used to hold down a pile of paper in the wind outside, or as a weapon, a tool, and so on. A cell phone becomes useless in the absence of a cellular transmission and reception infrastructure. Context of use is revealed by user observations and gives information on frequency, importance of the activities and the relation between activities and the environment.

Every day we make hundreds of small decisions regarding usage of objects and alternatives: we might decide to walk instead of taking the car, call instead of sending an email, take a familiar route instead of an alternative one, use the mouse versus the keyboard to delete letters, search for the remote control instead of interacting directly with the TV, etc.

People and probably all living beings make those small decisions, often unconsciously, based on energy and time saving, safety and comfort, and quality of the outcome.

This paper shows that by understanding subconscious decisions and fundamental human activities, it is possible to predict usefulness.

2. Basic human needs and activities

Although human lifestyles and motivations have changed over millennia, their basic needs have remained constant. People continue to feed themselves, defend against aggression, move around, keep warm and dry, meet and engage socially and sexually with others, experience pleasure, and exchange information. Those needs correspond to the physiological human needs described by Malinovsky [2] (nutrition, reproduction, domicile and dress, protection and defense, relaxation, and movement).

Maslow [3] associated human needs to a hierarchy. Human beings first satisfy basic needs, and then progress to the fulfillment of higher needs as affluence and security increase. Maslow defined five levels of needs:

1. Biological and physiological (food, drink, shelter, sex, sleep, energy and time conservation, etc.);

2. Safety (protection, security, order, law, limits, stability, etc.);

3. Love and belonging (friendship, family, work-group, affection, etc.);

4. Esteem (self-esteem, confidence, achievement, independence, status, dominance, etc.);

5. Self-actualization (realizing personal potential, self-fulfillment).

In order to meet these needs humans engage in a variety of activities. Some human fundamental activities include breathing, eating, drinking, sleeping, having sex, communicating with friends and family, observing others, reading, listening to or playing music, playing, travel, learning, looking for information, getting food, preparing food and competing for social status.

In the past people would feed themselves by hunting, fishing, or picking fruit. Today they get their food by earning money buying necessities from a grocery store.

Similarly although transportation has evolved from walking to using horses and carriages, then to driving cars and flying, the core activity remains "moving around." While the means used to engage in these activities have changed over time, the activities themselves have remained invariant.

3. Criteria people use for their decision

3.1 Time and Energy

People park their cars as close as possible to shop entrances to reduce walking time or the need to carry heavy loads a few extra meters. Informal paths running through parks or in front of buildings are established by people taking shortcuts by walking on the grass instead of using sidewalks [4]. The process of saving energy and time is universal in all living beings. The decisions that people make to save time are not based on deep analytical thought processes, but rather are intuitively made. This plays out, for example, when a typist needs to delete text while using word processing software. To eliminate text a user must either select the text with the mouse and push the "delete" key, or press the "backspace" key one time for each character of the text that is to be removed. When surveyed, users have difficulty describing how they choose between these options, because such choices are made subconsciously. When users are observed deleting text in real time, most will do so by pressing the "backspace" key a few times for shorter deletions (of four to seven characters) but use the mouse to delete larger blocks of text.

It takes about 1.2 seconds to delete a six character word (0.2 seconds per character) using the "backspace" key, while doing the same task with a mouse takes about 2.6 seconds. The larger the block of text, the longer it would take to delete it using the "backspace" key (recall the rate of 0.2 seconds per character), while the time needed to complete the operation using the mouse remains nearly constant at 2.6 seconds even with very large blocks of text. Users will subconsciously choose the option that saves them time and energy.

3.2 Safety

People will often take a little extra time to search for a staple remover rather than remove a staple by hand and risk discomfort or injury. When there are multiple staples to remove, the risk increases and people have a greater incentive to spend extra time to find the staple remover. Naturally, those who frequently remove staples will keep the staple remover handy. People routinely use tools to minimize risk (errors, injury, and pain)

3.3 Quality of the Outcome

When choosing a camera, people will choose one that produces better pictures, provided all other criteria are the same. Quality factors (e.g., image resolution) are measurable, and when viewing photos, people prefer higher quality ones (less blurred, higher resolution).

In summary people will choose devices that save time, energy, and provide safety and quality of output. All those criteria are objectively measurable and related to human basic needs.

3.4 Functionality and activities

When biking in a forest, a cyclist will need to avoid obstacles and change position to be safe from shocks. A bicycle with a suspension system would increase the comfort, though at the cost of adding to the weight of the bicycle. Conversely, a superior suspension would provide little comfort to a bike racer (on flat-surfaces), and the negligible benefit would not adequately compensate for the added weight.

If the frequency of a specific activity is high, the advantage of the associated functionality on overall usefulness is also high.

In the Origin of Species, Darwin notes that species with the right combination of traits produce more offspring and thus survive longer. By analogy products with features that provide more advantage satisfying basic needs for given activities will survive.

4. Comparing usefulness

Usefulness cannot be measured in isolation. Rather, the usefulness of an object must be compared to an alternative or a reference point.

Usefulness is evaluated by comparing a product to an alternative by:

1. Identifying the relevant fundamental set of activities.
2. Evaluating the importance of each activity by a weighting the activities in a given context.
3. Comparing advantages among the dimensions of time, energy safety, and quality of the outcome.
4. Calculating the resulting advantage for each dimension for all activities.

The weight of the specific activity (W (activity)) depends in large part upon the context in which it is used.

Aj (criterion) is the relative advantage of two compared objects, with respect to the given dimension (time, energy, safety, and quality), for the specific activity "j".

The total relative advantage with respect to the given dimension is then defined as:
$\Sigma j \ Aj*Wj$

Below we discuss a comparison of the usefulness of two objects based on these criteria: time, energy-comfort, safety, and quality of outcome.

4.1 Time

The formula for calculating time advantage is the following:

$T = \Sigma j \ Aj *Wj$

Let's compare walking and taking the car for going to a coffee shop at 100m and going to a store at 1Km:
If the subject goes to the coffee shop 90% of the time and to the store 10% of the time, then weights assigned to each activities will be: W1 = 0.9, W2=0.1.
Let's assume that it takes ten minutes to visit a coffee shop or a store by car. (For a short distance using the car takes the same amount of time as walking since the driver needs to find his keys, adjust mirrors, walk to the car, find parking etc….). Let's also assume that it takes a subject 20 minutes to walk to the store and five minutes to walk to the coffee shop. That means a person going to the store by car will save 10 minutes. But if the subject drives to the coffee shop (instead of walking) he loses five minutes (see Table 1).

Activity	Weight	Car	Walk	Car only
Going to coffee shop	.9	10	5	+5
Going to store	.1	10	10	-10

Table 1. Time advantage of using car vs walking

The result will be:

T (using car) = $\Sigma j \ Aj * Wj = (-5 * 0.9) + (10 * 0.1) = -3.5$

In this example a person loses 3.5 minutes on average when using a car only compared to walking. On the other hand, a simple change in behavior, in which the subject visits the coffee shop and store both once a day changes the relative weights of the purposes and thus the outcome:

T (using car) = $\Sigma \ j \ Aj *Wj = (-5 * 0.5) + (10 * 0.5) = 2.5$

In the first example, walking is advantageous by 3.5 minutes, while in the second using the car is better by 2.5 minutes. If the average for the relative time advantage were around zero, neither the car nor walking would be more advantageous.

4.1 Energy-Comfort

People often say things like: "I feel less tired when I use it", "it saves me work", "I am more comfortable". At core, products are more (or less) comfortable because they are more (or less) demanding on a subject's muscles or cognitive resources. This energy demand can be measured using the following formula:

E = Σj (Aj (energy) * Wj (activity))

When walking, people only typically notice energy demand when they have to carry a load. Unless the distance is long, healthy people generally do not feel tired when walking.

Similarly people rarely regard driving as work unless they have to carry a load from the parking lot to their final destination or vice-versa. Supplementary Energy used (E) can be calculated using the formula: E = F x D, where F = m * 9.8m/s2 is the force required to hold the load and D the distance travelled while carrying it. Let's also assume the subject must park 100 m from the

destination when travelling to either the coffee shop or the store, and must carry a 3 kg load 100m and 1000 m in the respective cases (where J is Joules).

Activity	Weight	Car	Walk	Car only
Going to coffee shop	.9	100 m	100m	0
Going to store	.1	100 m	1000m	-26.46Kj

Table 2. Energy advantage of car vs. walking

E (a) = Σj Aj (Energy) * Wj (activity) = -2.646 kJ

In this example, the subject saves no energy when using the car for going to the coffee shop, but does save when going to the store. In practice, people will choose driving for the longer distance and walking for the shorter one. But if people have to choose one option, walking saves time while using the car saves energy. These decisions are usually made subconsciously and factors combine both time and energy.

4.3 Safety

Safety is a subjective feeling, which varies based on the degree of trust or fear subjects have towards a product or situation. Fear can be induced by experience (e.g., an unreliable car, dangerous road, flight accidents, etc.) or by information (e.g., crime rate, fraud risk, TV/newspaper reports about accidents, etc.). On the other hand lack of negative experience means that subjects may underestimate risk. For example a fisherman who has fished on rough seas many times without difficulty may not be as worried as he should be.

For the previous example involving travel to the coffee shop and to the store, let's assume that the car is old, unreliable and occasionally breaks down. The estimated reliability using the unreliable car is 70% for long distances and 95% for short distances, while for walking it is 100% in both cases. The impact of an automotive breakdown is time loss. Let's assume it takes 30 minutes to fix the car.

When a closed feedback loop exists between action and reaction, safety and accuracy may impact time spent. It forces users either to spend more time on the given activity, by reducing speed to increase accuracy, or to lose time by waiting until the broken (out of order) object will be fixed.

The speed-accuracy trade-off relation is governed by Fitts's law [5]. In this example the number of minutes lost ((time lost in case of problem) x (probability of problem)) due to safety issues must be added to overall travel time spent in each alternative. If we do that, expected travel time by car increases (30 min x probability of breakdown), whereas walking time remains constant (let's assume that walking is 100% safe).

As we noted in the example above, using a perfectly reliable car, a person will lose 3.5 minutes on average when driving as opposed to walking. But if the car is unreliable, the subject loses 5.75 minutes on average.

In the case of no direct feedback between action and reaction, safety is integrated in a subjective manner. For example, the fear of having an accident while flying is common, often irrational, emotion. (Assume flying saves time compared to driving, but the person has a fear of flying).

4.4 Quality of the outcome

People judge quality, based on their perceptions and feelings. When a subject uses a product or object to achieve something, he links quality with the outcome.

For example when recording audio or taking a picture, the image or sound quality is key. The formula for measuring quality is:

$Q = \Sigma j\ Aj\ (quality) * Wj\ (activity)$

Quality plays a major role when assessing electronic devices such as MP3 players or cameras. That's because when a product encompasses little time, energy or safety advantage, its quality becomes the defining factor. This however may less be the case in work-related activities (where quality may take a back seat to safety, time savings etc…).

4.5 Integration of criteria

When several dimensions are considered, each one's relative importance needs to be taken into account.

In the example above, a subject loses an average of 3.5 minutes when using a (reliable) car as opposed to walking. When a person carries a load, they save more energy by driving. The choice is between two criteria (saving time or energy) and depends on additional information such as whether the subject is injured or time is scarce. An injured person will put more weight on energy than time. For a young and healthy person, energy concerns might be unimportant over a short distance with a small load.

Objectives may conflict, and dimensions used must be weighted based on knowledge of the target audience.

5 Application examples

5.1 Blackberry versus iPhone

Let's assume that in a Blackberry (those with qwerty keyboards) versus iPhone product assessment the target audience is working professionals. Their main activities are: talking, reading and writing short and long email/text messages. In this example, activity frequencies are: talking: 30%, reading messages: 60%, writing short messages: 7%, writing long messages: 3%, (see Table 3).

Activity	Weight	BB	IP	Time
Talk	.3	10	10	0
Read e-mail/text msg.	.6	10	10	0
Write short e-mail/text msg.	.07	1.90	2.63	-0.73
Write long e-mail/ text msg.	.03	9.48	13.16	-3.68

Table 3. Time advantage, Blackberry (BB) vs. iPhone (IP) (average users)

In this example energy and quality are assumed to be the same for both devices and safety is not a factor. As a result, the key usefulness criterion is time. Let's assume display quality is equal (In reality, the iPhone display is larger and has higher resolution than Blackberry allowing faster reading). Time measurements were made comparing users entering text in both phones. The formula used to calculate the difference is:

$$T(a) = \Sigma_j A_j(\text{time}) * W_j(\text{activity}) = -0.16 \text{ s.}$$

In this case, the Blackberry's advantage is negligible because it is under 0.2s. (Note that users don't perceive reaction time differences of less than 0.2s).

Now let's change the usage breakdown. Suppose the target audience's time is spent as follows: voice communications 15%, reading messages: 40%, writing short messages: 20%, and writing long messages: 25%. The formula used to calculate the difference is:

$$T(a) = \Sigma_j A_j(\text{time}) * W_j(\text{activity}) = -1.07 \text{ s.}$$

In this case, using the Blackberry would be advantageous.

Unfortunately for RIM, the assumptions for the first example are more realistic. People rarely write long emails on mobile devices.

In addition, display resolution and size are superior on the iPhone allowing faster reading and navigation. Consequently, the iPhone should prevail because the Blackberry text input advantage is not significant for most users. Furthermore the iPhone offers other value chain advantages such as the App store.

5.2 Internet Explorer, Firefox, and Chrome

Now let's look at a comparison of the Internet Explorer (IE), Firefox and Chrome browsers.

The target user population is comprised of young users between the ages of 15 and 30. Their main activities which we will compare are:

1. Opening a new webpage, with no browser open;
2. Navigating the web, with the browser open.

For young users, safety is of generally of low importance. Energy demand and quality are assumed to be the same for all browsers, meaning that the main usefulness criterion to be assessed, is time spent.

The resulting graph (data from experiments at other time points are not presented for brevity) is presented in Figure 1. Each curve shows the relative speed ratio of one browser versus the other.

For simplicity of presentation, we converted the time advantage measures into speed ratios, e.g. a ratio value of 1.5 means that Chrome is 1.5 times faster than the other browser in question.

Figure 1 shows that for the relevant activities Chrome (upper curve) featured 1.65 times faster performance than IE and 1.2 times faster than Firefox at the end of 2008 (when it came out).

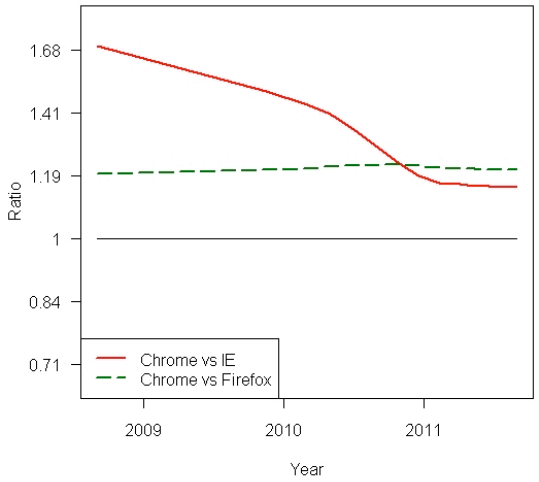

Figure 1. Time advantages of browsers

Chrome is now ahead in usage share percentage of the three browsers we compared above during the last two years (source: http://www.favbrowser.com/). The chart shows that Chrome usage share has been rising, while IE's and Firefox's shares have been falling. This indicates that Chrome's emphasis on speed, for everyday browsing and quick online searches, has paid off (speed is the most important criterion for young users in their browser evaluations).

5.3 iPhone versus Kin

Microsoft's Kin One and Kin Two mobile phones lasted for 48 days on the market until the company decided to discontinue them.

Though the device failures have been attributed to pricing, marketing, and distribution channels, Kin also failed to match the iPhone on its target audience's (Microsoft wanted Kin to target young adults between 15 and 30 years old) usefulness criteria. For this age range activity frequency is assumed to be: talking: 10%, texting: 50%, Facebook views: 30% and Facebook photo sharing 10%. For this young target audience, safety, quality and energy are assumed to be of low importance. Consequently, the criterion left for comparison is the time spent to complete operations on the device.

Keystroke comparisons for Kin and iPhone activities shows that there is no time advantage in using Kin for the social activities.

On the other hand, if Kin had been available before the Facebook application became available on the iPhone, then the device would have provided its target audience with a substantial advantage. Usefulness does not necessarily guarantee commercial success since consumers have no incentive to choose an alternative offering that provides no advantage.

5. Conclusion

The main challenge in measuring a product's usefulness is in determining the right set of specific activities that it will be used for and their relative weights in the user's overall decision making process. This requires a deep understanding of the target audience and its

behavior. While a product's usefulness alone does not explain commercial success or failure, measuring it allows one to put its relative advantages in perspective. If a product has no measurable advantage, executives and designers should make other concrete benefits apparent in the value chain such as pricing, distribution, support, etc. Understanding the needs and behaviors of target users enabled Google to identify the importance of the time criterion in browser use. As a result, even though Chrome was a latecomer in the browser war, it has gained a substantial market share.

Decision makers need to have comprehensive awareness of a product's potential usefulness before deciding to invest in it. In particular, they should focus on the activities for which it will be used and their relative weights for their target audience.

Countless failures can be linked to the inadequate assessments of these factors. For example, Steve Balmer, Microsoft's CEO, presided over the failure of Kin and wrongly predicted that iPhone would not succeed because users would prefer a physical keyboard in their mobile devices. Analysis of activity frequency (relative weights) shows that the Blackberry keyboard's superiority over the iPhone version, is negligible because users rarely write long emails on their mobile devices. Results show that the CEOs of the most important corporations can benefit from understanding product usefulness and how it can be measured.

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