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Measuring a product's usefulness

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Abstract. This paper explains how a product's usefulness may be defined and measured. Many aspects of consumer product assessments 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 fundamentals needs. When multiple criteria are involved, different weights are assigned to each. It should take into account the context in which the product is used. For the purpose of this paper, we use a formula to determine the relative usefulness of a variety of products in different contexts. We conclude that aspects of product's usefulness, connected with sub-conscious human decision making processes, can be a major factor in predicting acceptance and rejection rates.

Keywords: Usefulness, fundamental human activities, criteria of usefulness.

1. Introduction

A new product's commercial success depends on its capacity to bring benefits to consumers and users. One of the most important features of products is its usefulness.

Product's usefulness is defined as a tangible and practical advantage in time, and energy savings, and others.

Early evaluation of a new product's potential usefulness is highly recommended as it can help executives predict their market success before costly development or production investments are made. Using a product that provides real advantages triggers feelings of user satisfaction. This translates into positive impacts as users make repeat purchases and share their experiences with others.

A key distinction needs to be made between a product's usefulness and its usability [6]. "Usability is the extent to which a product can be used by specified users in a specified context to achieve specified goals effectively and efficiently [3]." An object with great usability might not be the most useful to consumers if it does not include required functionalities for a given activity [4]. For example, a user might prefer a poorly designed MP3 player because some required functions such as recording audio or radio are not available in a more usable version.

However when users face a choice between objects that include the same set of functionalities, usability becomes the driving factor. The practical advantages of an object reveal themselves through activities. 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, and as a weapon, a tool, and so on.

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In the business world, objects are assessed on their cost relative to the value they deliver. This paper concentrates on aspects of product usage connected with sub-conscious [2] human decision-making processes (the decision regarding whether to use a mouse versus the keyboard)[3]. The criteria used to make these decisions such as time saved, energy expended and the security and quality aspects of various products have not been extensively discussed in published literature. This paper initiates such a discussion and shows that usefulness can be measured objectively.

2. Basic human needs and activities

People's fundamental need and activities must be understood prior to properly assess product usefulness.

Although peoples' lifestyles and motivations have changed over millennia, their basic needs have remained relatively constant. People continue to need 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 [1] associated human needs to a hierarchy. He believed that all healthy human beings move from first focusing on fulfillment of the basic needs to progressively concerning themselves with higher needs as their affluence and security increases. 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, workgroup, 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: such as seeking food, drink, looking for information, traveling, etc. These activities can be looked at from two perspectives:

– While the means used to engage in these activities changed over time, the activities themselves remained constant. For example, in the past people would feed themselves by hunting, fishing, or picking fruits. Today they get their food by earning money and going to the grocery store. Yet the basic activity remains constant: feeding oneself. Similarly although transportation has evolved from walking to using horses and carriages, to driving cars and flying, the core activity remains "moving around."
– A single activity can satisfy several needs simultaneously. For example, the search for information can satisfy the need for food (e.g., where to buy food) and safety (e.g. how to build a safe house, etc.).

Socialmode.com provides a list of human fundamental activities. These include breathing, eating, drinking, sleeping having sex, communicating with friends and family, observing others, grooming, working (desk job, factory job, etc.), reading, listening to or playing music, playing, travel, learning, preparing food and competing for social status.

Every day, human beings make hundreds of micro decisions on whether or not to use a product, and when using the product, whether or not to use a particular functionality encompassed within, etc. Those decisions are often made unconsciously and are strongly associated with conservation initiatives such as the desire to save energy and time, and to ensure safety and comfort.

2.1. Saving energy and time

Humans are constantly adapting to expend the least energy possible to achieve their objectives. In most cases, this behavior seems to be subconscious and not based on a deep analytical thought process. For example, people park their cars as close as possible to a shop doors to reduce walking time or the need to carry heavy loads a few extra meters. Another example can be seen in the informal paths running through parks or in front of buildings, produced by people taking shortcuts by walking on the grass instead of using sidewalks. This process of saving energy and time is universal in all living beings.

The decisions that people make to save time are often done unconsciously. This plays out for example when they need to delete text while using word processing software. To eliminate text users must do

[2] Not consciously held or deliberately planned or carried out (from Merriam-Webster dictionary).

so either by selecting text with the mouse (and pushing the "delete" key) or by pressing the backspace key repeatedly for each character of the text that they want to remove. When surveyed, users have difficulty describing their choices in this matter because these 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 (four to seven times) instead of using the mouse to delete a few letters. To delete a six letter word, using the backspace key takes 1.2 seconds. Doing the same task with a mouse takes 2.6 seconds[4]. In short users will choose the mouse deletion method when there are longer text blocks to delete. They will subconsciously choose the option which saves more time and energy.

A driving versus walking decision is another example of subconscious decisions people make about their time. A person might decide to drive to go to work. But when going to the coffee shop located in the next block, he might decide to walk because the car takes more time and he wants to get some exercise. In short, time saving is an important criteria that consumers use when evaluating the advantages of using a product versus not using it.

The desire to save energy can also be part of the unconscious decision making process. In the "going to the coffee shop" example, if the subject had a heavy bag to carry, it might be worth it for him to take the extra time and drive. Here, his choice would be based in part on the energy/comfort criteria.

2.2. Ensuring safety

Users also routinely use tools to minimize risk (errors, injury pain). For example, a person will often take a little extra time to search for a staple remover rather than to remove a staple by hand. When there is just one staple to remove, he may attempt to do so with his fingers, thus risking injury. However when there are multiple staples to remove, the risk increases and a person will have a greater incentive to spend extra time to find the staple remover. Naturally, those who routinely remove staples will keep the staple remover handy.

[4] The time of Homing (.4s), plus time of pointing and selecting (1.6) plus the time of pressing delete (.6) vs. pressing six time a key (6x0.2s = 1.2s).

2.3. Quality of the outcome

Many activities give rise to rich user experiences and feelings: for example, taking a photo, listening to music, watching a movie, etc. Statistically, when choosing between a variety of photos, people prefer higher quality ones (less blurred, higher resolution). Thus when choosing a camera, consumers will choose those that produce better pictures, provided all other criteria are the same. Quality factors (e.g., image resolution) are in many cases measurable.

2.4. Product functionality and context of use

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

For example when biking in a forest, a biker will need to avoid obstacles and change position to protect himself against shocks. A bike with a suspension system would increase his comfort, though at the cost of adding to the vehicle's weight. Conversely, a superior suspension would provide little comfort to a bike racer (on flat-surfaces), and its extra weigh would be unlikely to compensate for the benefits it provides.

In summary, a product's "usefulness" is its ability to procure the user a practical advantage for a given purpose in a given context, relative to not using the object or using an alternative one. This advantage is related either to the user's time and the energy he expends (muscle strain, fatigue, etc…), safety (accuracy, reliability, and trust), and the outcome quality.

In *On the Origin of Species,* Darwin notes that species with the right combination of traits produce more offspring and thus survive longer. Similarly in the marketplace, products with features that better satisfy consumers' basic needs, also have better long-term survival rates. When comparing the relative usefulness of two products, we need to first identify the target population's activities, and to measure the relative advantages of each product in term of time and energy, increased safety, better quality and so on). Since the relative importance of those fundamentals needs is unlikely to be equal, each is assigned a relative weighting in the overall "usefulness" measurement.

If we refer back to Maslow's hierarchy of needs, the time and energy savings noted above relate to a consumer's "physiological needs," while predictability and risk of getting injured are associated with "safety needs."

3. Comparing usefulness

Overall product usefulness may be evaluated by:

- Identifying the user population and noting its behavior;
- Identifying the fundamental and associated activities;
- Assigning a weight to the relative importance those activities in a given context;
- Comparing a product's usefulness with one or more alternatives. This comparison is based on its performance in terms of criteria such as time and energy used, how safe it is and its overall quality. Overall weights are assigned to each criteria based on their relative importance to users.

The weight of the specific activity ($W_{(activity)}$) depends in large part upon the context in which it is used. $A_{(criterion),j}$ is the relative advantage of two compared objects, with respect to the given criterion (time, energy, safety, and quality), for the specific activity "j".

The average advantage with respect to the given criterion is then defined as:

$$\Sigma_j (A_{(criterion)\,j} * W_{(activity)\,j})$$

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

3.1. Time

The formula for calculating time advantage is the following:

$$T = \Sigma_j (A_{(time)\,j} * W_{(activity)\,j})$$

Let's compare two specific activities:

- Travelling 50 meters to a nearby coffee shop;
- Travelling to a store one kilometer away.

A subject may visit either destination by car or on foot. 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 purpose will be: $W_1 = 0.9$, $W_2=0.1$.

Let's assume that it takes ten minutes visit the coffee shop or 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).

Table 1

Time advantage of using car vs walking

Activity	Weight	Car	Walk	A_{time} (min)
Going to coffee shop	0.90	10.00	5.00	-5.00
Going to store	0.10	10.00	20.00	10.00

The result will be:

$$T_{(a)} = \Sigma_j (A_{(time)\,j} * W_{(activity)\,j}) = (-5 * 0.9) + (10 * 0.1) = \mathbf{-3.5}$$

In this example a person loses 3.5 minutes on average when using a car 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:

$$T_{(a)} = \Sigma_j (A_{(time)\,j} * W_{(activity)\,j}) = (-5 * 0.5) + (10 * 0.5) = \mathbf{2.5}$$

In this case using only the car for both activities will save 2.5 minutes on average. In the first example, walking is advantageous, while in the second using the car is better. If the average for the relative time advantage were around zero, neither the car nor walking would be more advantageous.

3.2. Energy-Comfort

People often say things like: "I feel less tired when I use it, it saves me work, I am more comfortable". At their 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:

$$E = \Sigma_j (A_{(time)\,j} * W_{(activity)\,j})$$

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. Energy used (E) can be calculated, using the formula: E = F x D, his

Table 2

Energy advantage of car vs walking

Activity	Weight	Car	Walking	A_{energy} (J)
Going to coffee shop	0.90	10.00	5.00	-1470 [5]
Going to store	0.10	10.00	20.00	26 460 [6]

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

$$E_{(a)} = \Sigma_j A_{(Energy)\,j} * W_{(activity)\,j} = \mathbf{1323J}$$

In this example, the subject saves more energy when using the car. However a simple change in context also changes the outcome. For example if the subject discovers a similar store 500 meters away. The outcome then becomes (see Table 2):

$$E_{(a)} = ((-1470 * 0.9)+(11760J * 0.1)) = \mathbf{-147J}$$

Hence, walking now saves more energy. Note that this example is kept simplistic for illustration purposes. In practice, people will choose driving for the longer distance and walking for the shorter one. These decisions are usually made subconsciously.

3.3. *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 knowledge or experience means that subjects may not experience fear where they should. 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 above example let's assume that the car is old, unreliable and occasionally breaks down. When "going to the store", the estimated reliability using the unreliable car is 70% on long distance and 95% on short distance, while for walking it is 100% in both cases. The impact of broken car 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[7][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 there are safety issues due to the fact that 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).

3.4. *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:

$$Q = \Sigma_j A_{(quality)\,j} * W_{(activity)\,j}$$

Quality plays a major role when assessing electronic devices such as MP3 players or cameras.

[5] E (Activity 2/walking) (3kg * 9.8m/s2 * 50m) - E (Activity 2/Car) (3kg * 9.8m/s2 * 100m)

[6] E (Activity 1/walking) (3kg * 9.8m/s2 * 1000m) - E (Activity 1/Car) (3kg * 9.8m/s2 * 100m)

7 For pointing tasks, Fitts's law precisely models how task precision affects pointing completion time: T = a + b log 2 ((D + W)/W), where a and b are constants reflecting the efficiency of the pointing system, D is the pointing distance, W is the target width and T is the mean (expected) time of task completion.

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…).

3.5. Integration of criteria

When several criteria 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 the subject carries a load, he saves more energy by driving. The choice is between two criteria (saving time or energy) and depends on additional information such whether the subject is injured or time is a factor.

In the above example, if the target audience is "retired person on vacation," then time is less critical and saving energy is of greater importance. As a result the choice would then be to drive. If the target audience is young healthy professionals during working hours, time spent is critical and walking is thus preferable.

In short, choosing between conflicting objectives is common and the criteria used must be weighted based on the target audience.

4. Application examples

4.1. Blackberry versus iPhone

Let's assume that in a *Blackberry 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 e-mails: 7%, writing long emails: 3%, (see Table 3).

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 criteria 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:

$$T_{(a)} = \Sigma_j A_{(time)j} * W_{(activity)j} = -0.16 \text{ s.}$$

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

Activity	Weight	Blackberry	iPhone	T_{time} (sec)
Talk	0.30	10.00	10.00	0.00
Read e-mail/text msg.	0.60	10.00	10.00	0.00
Write short e-mail/text msg.	0.07	1.90	2.63	-0.74
Write long e-mail/ text msg.	0.03	9.48	13.16	-3.68

In this case, the Blackberry's advantage is negligible because it is under 200 ms. (Note that users don't perceive reaction time differences of less than 200 ms).

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 emails: 20%, and writing long emails: 25%. The formula used to calculate the difference is:

$$T_{(a)} = \Sigma_j A_{(time)j} * W_{(activity)j} = -1.07 \text{ s.}$$

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.

The only considerable upside left for the Blackberry is its reputation regarding information security at the corporate level (safety) that RIM still holds (while security is not a factor for individual users, it is central for corporate CIOs).

4.2. 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[8],

2) Navigating the web, with the browser open[9 10].

For young users, safety is of generally of low importance.

[8] The average browser opening time is added to the average load time of the most popular websites.

Energy demand and quality are assumed to be the same for all browsers, meaning that the main usefulness criteria to be assessed, is time spent.

The resulting graph (data [11] 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).

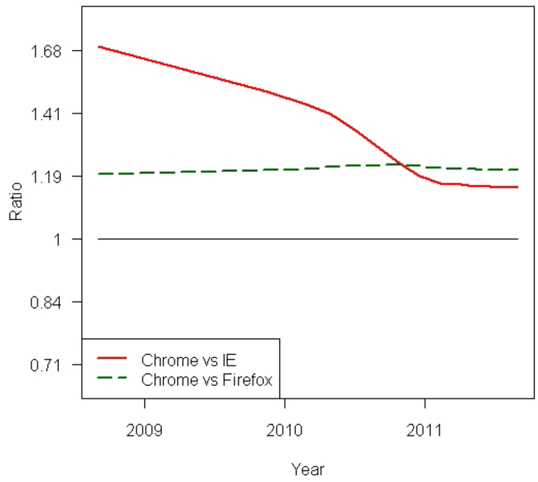

Fig. 1: Time advantages of browsers

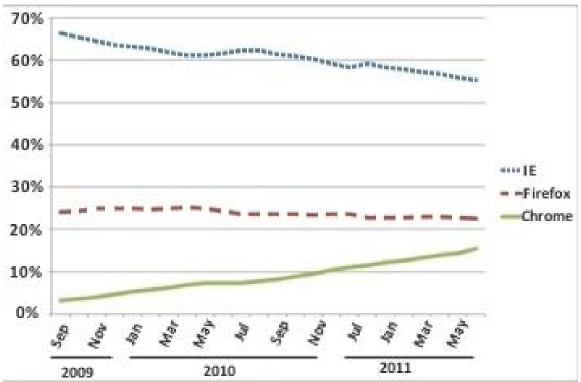

Fig. 2: Usage share of browsers

In short Chrome comes out ahead. Figure 2 shows the 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 main criterion used by young users in browser evaluations).

4.3. 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 main criteria 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. While usefulness does not necessarily guarantee commer-

9 Combine the time of opening new websites with predefined memory and CPU usages. Memory and CPU usage have a direct effect on browsing time.

10 Download and use files, read texts and documents online, play games, view videos, listen to music online were not considered since browser has less of an impact on those activities performance.

[11] One test published in http://www.techradar.com in 2008, 5 tests published in http://www.tomshardware.com in 2010 and 2011, corresponding to new version releases of the browsers.

cial success, 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 behaviour. 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 behaviours 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 should put a major effort in understanding 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 activities. 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 one of the most important corporations can benefit from understanding product usefulness and how it can be measured.

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