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Kilograms or cups of tea: Comparing footprints for better CO_2 understanding

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ABSTRACT

Individuals are now often presented information about greenhouse gases in their everyday life. However, there seems to be a gap between this increase in the exposure to carbon dioxide information and the understanding of how to interpret it, making behavioral change difficult. This article presents examples of how different applications have dealt with this problem by representing the carbon dioxide information in different ways. Based on the existing examples, an application called carbon.to was developed and released. This service tries to improve the understanding of carbon dioxide information by simulation in a playful way. Feedback from the users points towards that the gap in understanding existed and that carbon.to was successful in helping closing it.

Keywords: *carbon dioxide, climate change, graphic design, visualizations, persuasion, sustainability.*

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1. Introduction

Climate change and carbon dioxide emissions have become a part of the public debate in the last years. An inflexion point can be seen during 2007 when An Inconvenient Truth, a documentary about global warming starring Al Gore, won the Academy Award (Gorman, 2007), and when Al Gore and the Intergovernmental Panel

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on Climate Change shared the Nobel Peace Prize (Nobel Foundation, 2007). This spreading of climate change in the media is reflected in the increased public knowledge about the subject. Carbon dioxide, a term mostly used in biology and chemistry, has become an everyday word and individuals are now often presented information about greenhouse gases in their everyday life (see for example Figure 1).

Figure 1. Max burger menu indicating 1.9kg CO_2 per meal (Max, 2010).

However there seems to be a gap between this increase in the exposure to carbon dioxide information and the public understanding and interest of how to interpret it and act upon it. Most individuals are, indeed, familiar with the concepts of climate change and carbon dioxide emissions (Whitmarsh, Seyfang, & O'Neill, 2010) and in Sweden it is estimated that hundred percent of the population is familiar with climate change and global warming (Naturvårdsverket, 2008). However, when presented with quantitative carbon dioxide information they are unable to make a connection between carbon and their personal actions whereas the role of the industry is often given much more importance (Lorenzoni, Nicholson-Cole, & Whitmarsh, 2007).

Our hypothesis is that people lack understanding of carbon dioxide information and ability to connect it to everyday decisions. This understanding could be improved by using different persuasive technology techniques.

The aim of this article is to study the ways to improve the understanding of CO_2 quantitative information through the use of computer tools.

This article follows a design-oriented method. Based on a problem area and the existing solutions a real life intervention is designed, developed, and released to the public. The feedback from the users is gathered to contribute to the improvement of the next iteration of the application. This methodology originates from traditions in design research (Brown, 1992; Hoadley, 2004; Barab & Squire, 2004). Persuasive

Technology and Captology (Fogg, 2003) is used as the theoretical base for the computer based behavioral change intervention.

The objectives of the design process are:

- Identifying the problem area.
- Collecting existing examples.
- Designing and implementing a design intervention
- Testing the intervention and gathering feedback.
- Proposing the next research questions based on the results.

2. Pre-study

The first step in the design process was to explore existing examples of representation of carbon dioxide information; different efforts for making the information easier to understand:

- Dopplr[1] presents the emissions graphically in bars so it is easier to see the scale differences. In Figure 2 for instance the difference between train trips (the very short bars) and a long flight (long bar at bottom) can be seen clearly.
- WWF carbon calculator (WWF, 2010) presents the result in relation to how many planets would be needed if everyone lived like the user. It uses a normative baseline as a recommended goal (living under "one planet" footprint) and the carbon information is presented in relation to it.

Figure 2. Dopplr (left) and WWF (right).

- Leake and Woods (2009) published that two searches on Google accounted for 7 grams of CO_2, as much as boiling water for a cup of tea. The story was refuted, but the use of the analogy of the cup of tea was a success, making

[1] A service for travelers where the emissions of all your traveling can be calculated. See http://dopplr.com

the information much easier to grasp. The story was also used as headline for later articles as "*A Google or a Cup of Tea: which warms the globe the most?*" (Treehugger, 2009).

- Volkswagen (2010) uses an iPhone application to demonstrate how little their new eco-fuel model emits. The user blow in the microphone and it calculates how many kilometers the car can travel emitting the same CO_2 as the breathing contains.
- Dopplr, in its yearly report that it sends to its users, compares the total carbon footprint with how much driving a Hummer during a year emit (see Figure 3).
- Jazzcalculator[2] a web service also from Volkswagen follows the same concept. It compares the CO_2 emitted by driving a Volkswagen to the number of hours that a jazz band needs to play for emitting that (based on the breathing volume). For instance a trip of 200km emits 4,14kg of CO_2 that equals 6:56 hours of jazz jamming (see Figure 3).

Figure 3. Dopplr Hummer (left) Volkswagen jazzcalculator (right).

Most of the examples above have in common that they translate carbon dioxide into other units that could be more easily grasped. These alternative representations try to get around the fact that quantitative carbon dioxide information is difficult to grasp and to put in context. By using representations that users can relate to – things and actions encountered in everyday life – a greater understanding of climate impact is expected.

3. Method

[2] Available online at: http://www.jazzcalculator.com/

Based on the previously explored examples we designed and built an intervention to make carbon information easier to understand. The design solution gave us the opportunity to test our ideas as well as getting feedback from users. We created a web service called Carbon.to[3] that allows users to improve their understanding of carbon emissions in a playful way by providing the possibility to convert and compare between different units. The units are carbon footprints of different everyday products and services such as kilometers by car or number of bananas. The idea is similar to the presented concepts transforming CO_2 information into equivalent representations, but allowing the user to choose the units and quantities for a more dynamic and personal experience. The application was programmed using Ruby on Rails[4] and the source code is released as open source[5].

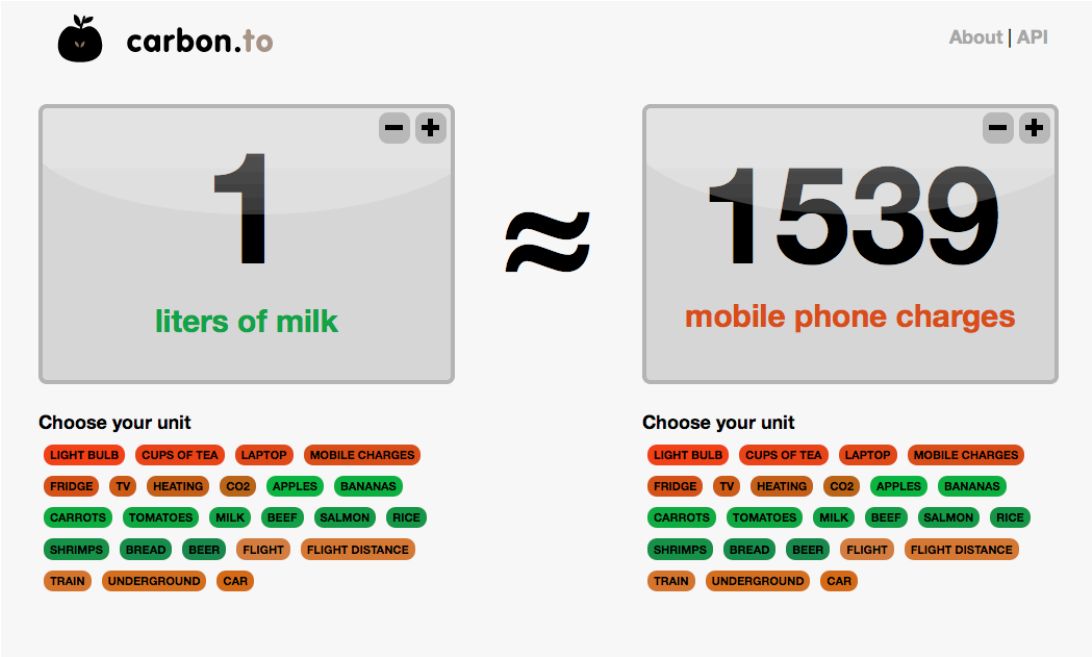


Figure 4. Screenshot from application.

When the application starts, it displays 1 kg of CO_2 in a random unit (see Figure 4). The user can add or subtract, and compare any two units with each other. For example it is possible to see how many mobile charges that are required to emit the same amount of CO_2 as flying for 5 hours. The application converts between 23 different units.

[3] Available at http://carbon.to
[4] More information at: http://rubyonrails.org
[5] Source code is available at: http://github.com/hinke/Carbon.to

The application emphasizes that there are uncertainties about the calculations. This is represented by the use of the symbol ≈ instead of equal, and explained further in the available references[6].

3.1 Designed persuasion techniques

The intent of carbon.to is to increase the understanding of carbon emissions through a learning process by simulation. The users compare different choices and different products by playing with the units. This helps the user to explore the cause-and-effect relationships and works as a simulation for the real moment of decision. The use of computers as simulation tools is one of the key features in computer-enabled change of user behavior and attitudes (Fogg, 2003). Simulation is a powerful form of persuasion technique because it persuades in a subtle way, without seeming to preach. The persuasion effect is thus embedded in the design. Following Fogg's (2003) persuasive technology framework the main principles at work are:

- *Principle of Virtual Rehearsal*: The tool enables experimentation without consequences. Users can compare different footprints and behaviors while not emitting.
- *Principle of Cause and Effect*: The intervention is designed to show clearly the link between cause (behavior) and effect (CO_2).

3.2 Data gathering

The intervention was released to the public on September 2009 and it was announced using social media. The study does not include any mechanism that allows the authors to control the included subjects. One could argue that the characteristics of the subjects are part of the result and they will be presented as such.

During its first year it has received more than 7500 visitors from 76 different countries, most of them coming from blogs[7] and social media sites as Twitter[8] and Facebook[9]. These channels provided also a direct feedback connection, where the users wrote about their experience with the services and their opinions. Most of this social feedback was gathered from the first weeks Carbon.to was online.

A logging system was programmed into the application to get detailed information of the usages. It saves each interaction (any time the numbers change, as when

[6] The references for the units are publicly available at: http://docs.google.com/View?id=dcqj9r34_206vr9hpqg8
[7] For instance from: http://eco.microsiervos.com/practico/calculadora-equivalencias-emisiones-co2.html
[8] http://twitter.com
[9] http://facebook.com

changing units or increasing and decreasing the values) in a SQL database. The logging system was released in May 2010 and it is still running, getting more than thousand interactions per day.

4. Results

The data gathered from Carbon.to are of two different kinds. The logs give us very detailed information about *what users have done* in the site, what they have compared, and how much have they clicked. The social media feedback, on the other hand, gives us a glimpse of *what users thought* of the site and what did they find interesting.

4.1 User logs

After six months (May 2010 to November 2010) it had recorded more than 100000 interactions from 2800 users. Real time statistics can be accessed online[10]. The user logs shows the most compared units (the initial comparison that is randomized is not included) are shown in Figure 5.

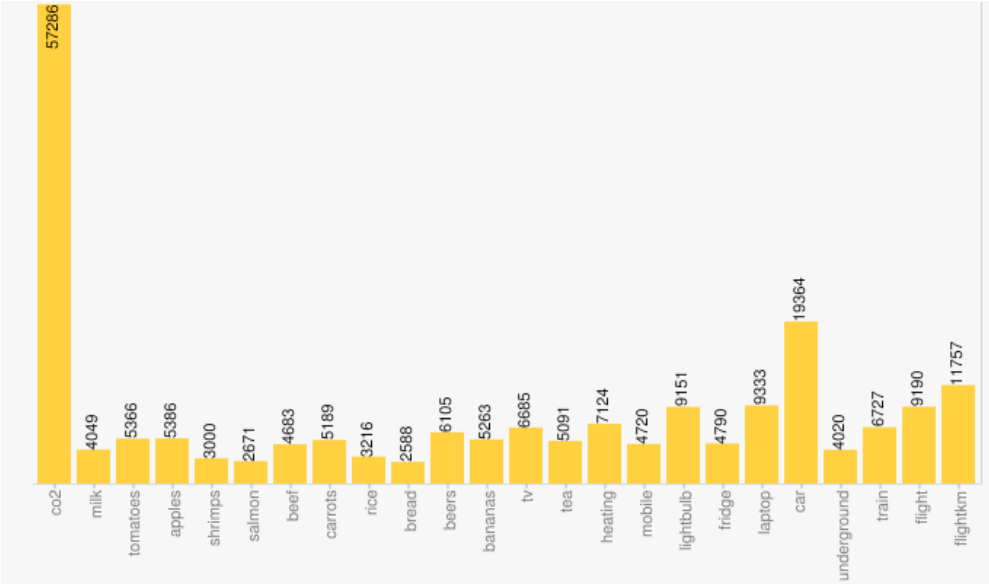


Figure 5. Logs from carbon.to for six months.

[10] Live statistics: http://carbon.to/showlog

The results have been consistent over time. It can be easily seen through comparing the previous graphic with the preliminary results after just one month (logged in May 2010) (see Figure 6).

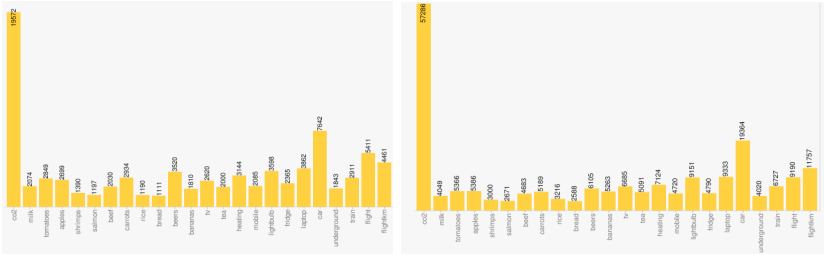


Figure 6. Log for one month (left). Log for six months (right).

From the logs we draw the following conclusions:

- Users were very active on the site, changing units and playing with the numbers. The average number of interactions is nearly 40 per user.
- Most interactions (roughly a third) were comparisons between CO_2 and something else, while comparisons between two different units were less popular.
- Car was by large the most used unit. Other popular units are flights (hour and kilometre), hours using a lightbulb and hours using a laptop. Food units were less popular.

4.2 Social media

The feedback from real users was the key for evaluating the effectiveness of the effort and for the input to the next iteration of the design process. Most valuable were the reactions from Twitter[11]. Most responses including a link to the site were mainly a way of people to share the link with the followers, for instance:

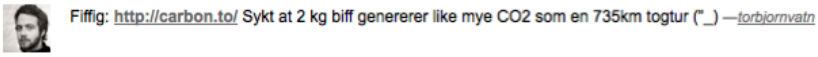
fairandbare: "Here's an interesting app converting carbon into units you might actually understand…"

There were some comparisons that surprised the users because the unbalance in the impact. For instance beef is known to have a high climate impact, but it's when in

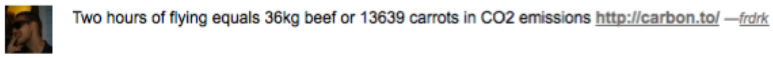
[11] All the "tweets" linking to carbon.to were found at:
http://www.backtype.com/domain/carbon.to/conversations

comparison with another unit as travelling by train where the size of this impact can really be seen. Comments included the following:

jant: "1kg beef ≈ 2542 cups of tea"

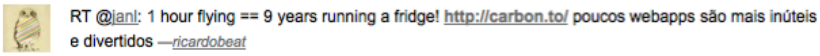


torbjornvatn: "2 kg beef generates as much CO_2 as 735 km in train"

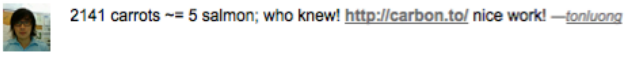


frdrk: "2 hours flying ≈ 36kg beef ≈ 13639 carrots"

Other activities that had the same effect were salmon and flying with tweets like*:*

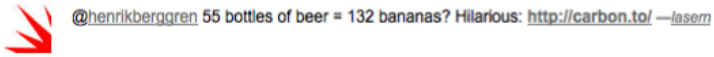


ricardobeat: "1 hour flying ≈ 9 years running a fridge!"



tonluong: "2141 carrots ≈ 5kg salmon, who knew!"

Some comparisons were appreciated just as entertainment, for instance:



lasern "55 Bottles of beer ≈ 132 bananas? Hilarious"

Even if this feedback is not from a controlled source it provided us with several interesting ideas for future development:

- In general people liked the application and thought it was **fun to use**. This "fun" factor was one of the things we tried to generate from the design process, including units as bottles of beer. This makes the figures less intimidating and more fun, which contributes to making carbon impact less abstract.

- The users were **surprised by the relationships between different emissions**, for instance the high impact of beef. We think that this have a positive impact in the users understanding of carbon dioxide information. They learn or confirmed that beef has a high carbon footprint, but they did it through their own interaction, not only by reading, but as an embodied experience of trying and playing.

5. Discussion and conclusions

The aim of this article was to get a deeper knowledge of the ways to improve the understanding of carbon dioxide information. As the importance of global warming has grown rapidly, there is a gap between the public awareness and the skills needed to act in accordance. Carbon dioxide information is difficult to understand since it is presented through several layers of abstraction. This article explored different strategies that have been used to overcome these difficulties such as having a baseline and comparing or translating with other units.

From this problem domain and the existing strategies we developed carbon.to as an intervention to improve carbon literacy. The site provides people with a tool to help them improve their understanding of carbon dioxide information through a process of play and simulation. Following a design approach we developed the service and released it in an early stage, getting feedback from real users through their interaction with the site and their responses from social media.

The users were mostly people arriving via the social media channels where carbon.to was released. No other characteristics of the users were gathered. They were most likely experienced Internet users and not uninterested in environmental issues. Most importantly, they represent the potential users of carbon.to, since they choose to click on the link and interact on the site. Therefore, their comments are valuable and interesting information for the developers. We argue that this method of getting feedback is successful both in providing data as well as getting candid responses.

In terms of impact, the intervention is a success with several thousand visitors coming from seventy different countries, and activity around it in social media channels. In the feedback we could see that the users were active on the site, playing and changing units many times. The most used unit was kilometers by car. This was unexpected, as it was not as “fun” as other unit and it points that kilometers driving is a

type of quantitative information that many people can relate to and put into the context of their life. From the social media feedback we could see that users found the application entertaining and they were surprised by many of the results. In terms of increasing carbon literacy, we get a hint from the feedback presented that it was effective in increasing the knowledge and awareness in the area. We would however need to explore the matter more deeply to be able to say anything about the real effect on their understanding of carbon dioxide.

More studies are needed about the connection between the exposure and availability of CO_2 information. They should particularly look into the users' understanding of this information and the impact of the strategies for increasing it. From our intervention we can see that there are great possibilities for applications to help both the users understanding and our own comprehension of the process.

6. Acknowledgments

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