An Exploration of Waste Management

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Introduction

Waste is defined as an unwanted by-product of a manufacturing process, and humankind has littered the environment as a consequence of its clear inability to deal with waste. All parts of the lithosphere, atmosphere and hydrosphere have become heavily polluted by waste. The magnitude of waste has reached alarming rates that even landfills are overcapacity. The increases in greenhouse gasses demonstrate the effects of mass production by fossil fuel reliant industries. The ocean has also suffered from solid waste intoxicating its ecosystems.

A person's ecological footprint adds up all the resources that go into every experience a person encounters. According to calculations, we will need ten times the amount of land we currently have to support the increase in humankind around the world. However, our collective garbage is overflowing and we cannot source places to put the trash anymore.

Our group hopes to provide a visualization that educates the users about waste management for more responsible waste disposal. Our goals are to inform and to improve the audience's spatial awareness of how much waste has accumulated. In addition, we want the audience to form small but effective habits of managing trash. The impact of mismanaged trash has a huge potential to harm the environment, wildlife and humans [2].

Related Work

There has been a lot of work to educate the general public about waste sorting and the benefits of recycling and composting. These could range from something as small as having images at the top of trash bins to show what goes into which bin (Figure 1) to something larger like hosting waste reduction programs for organizations like schools and companies.

Figure 1: The trash bins at MIT's Lobdell Dining Hall; each bin has an image at the top to help people decide where their trash should go into [1].

There also has been data produced by some environmental agencies to make people aware of the current waste state around the world. For example, the United States Environmental Protection Agency (EPA) releases yearly data on a wide range of topics around waste management, such as Municipal Solid Waste (MSW) generation, recycling, composting, other food management, combustion with energy recovery and landfilling [2].

There are also organizations such as the Aluminum Association that not only produces data on recycling rates but also data on how much recycling can save economically and environmentally [3].

Many organizations including the EPA and the Aluminum Association release charts and graphs to visualize the current state of waste management around the world. These visualizations are mostly line

graphs, pie charts, and bar graphs, only the generic static data visualization encodings.

There has been some more visualization work done by organizations such as Save On Energy, who produce more involved visualizations. For instance, they have provided a timelapse visualizations of the landfill evolution involving a US map view, choropleths representing landfill gases produced by each state, and comparison of waste amount with animals and famous landmarks [4].

Methods

Trash Sorting Activity: For the first section of our page, we provide an activity for the users to test their knowledge of trash sorting. In this section, we use drag and drop functionality using JavaScript. Trash items were selected from the list of commonly missorted items of trash on SF Weekly [5] and some other random items we believed would add value to this project. Tooltips were provided for each item to describe each item further to lessen confusions from users. The colors of the trash bins were selected to match with the industry standards. Upon completion of the sorting activity, users are taken to view the items they missorted and the reasons behind why the missed items belong in the said category, and the users are also prompted to a popup modal that provides more information about different types of waste. We are hoping that this initial activity can engage the users and be aware of their knowledge on waste sorting before moving onto the next parts to learn more about the current waste management around the world.

Bulldozer Representation: Whether the user did well or poorly on the trash sorting activity, we are hoping that this big message on the amount of waste produced around the world in 2018 along with its scale represented by bulldozers can provide a lasting impact for the users to explore more.

World Trash Visualization: We provide multiple ways for the users to interact with the world trash visualization.

The first part of this visualization is a bubble map. The data used was from the World Bank [6]. We cleaned the data by removing countries with missing values that we would need in the visualization. We also did calculations such as dividing the total amount of waste by the country population, which was already provided in the dataset. We provide views for exploring total waste produced by country and also the total waste per person in the specified country. While we did not provide the functionality to look up a country name, we used distinct colors to represent countries within each region (such as South Asia, North America) and also the map view (will be discussed in the next paragraph) to facilitate the looking up of specific countries. The bubbles are scaled to represent the amount of trash for each country, whether the users are viewing the country-wide data or individual person data. Hovering over each bubble shows a tooltip for the users to explore further about that country; the tooltip includes data such as the total amount of waste produced in the country, total population, and the per-person data provided in both tons and pounds.

As mentioned in the previous paragraph, a world map view is provided as another way to explore the state of waste around the world. It is also important to note that upon clicking on a bubble from the above section, it would zoom into the selected country on the map view to provide the users with more location knowledge; for example, if a user were to pick on a relatively big bubble for per-person data such as Moldova but was not sure where the country was, the user would be able to view the location of the country on the map and explore if there are trends or outliers with other countries. The world map itself is a choropleth that provides the users with quick data on which countries produce more waste, whether as a country or individually. We have picked darker encodings to represent the countries with more waste. Hovering on each country shows the name of the country. Clicking on countries makes those country names appear on the right side, which the users can compare side by side.

A feature that some users desired from our initial feedback was to be able to compare and contrast multiple countries' data side by side in a bar graph. Upon selection of countries and after the "Compare Countries" button has been clicked, the data for the selected countries show up on the bar graphs at the bottom. The users have the ability to select the top 3, 5, or 10 countries to compare, and those countries are ordered from the most waste to the least. Toggling the "Total Tons of Waste" versus the "Tons of Waste Per Person" also makes changes in the bar charts automatically, if countries were already selected at the time of togging the options. The color of the country from the choropleth persists onto the bar charts as well.

We also provide the functionality to view the state of waste just in the US as a hyperlink at the top of the page, which users can use to learn more about a specific state within the US if they wished. Data was collected from the EPA [7], and information for each state was collected using the state provided for each data point, and calculations were done to get the minute-wise and second-wise trash data for each state. For the United States Landfill feature, the main goal was to put a sense of scale to the "millions of tons" of waste that the World Waste feature visualized. Therefore we utilized metrics of trash such as garbage bins and dumpsters for users to guide their visualization of waste.

Aluminum Impact: In the last major section of this project, we provide the users with some information on how recycling (or sorting trash correctly) can make an impact to the environment. We wanted this section to be interactive and have the user go through each section to be more aware of the impact recycling can make. For now, we used aluminum data since the statistics provided by the Aluminum Association [3] was the most thorough and reliable of other common recyclable materials. We use a pie chart to visualize the difference in energy between new aluminum made from ore versus recycled aluminum. Furthermore, images such as oil barrels and cars are used to represent the impact of recycling aluminum. There is also a walrus to help users understand better how much a ton of trash weighs. This section leads to the last section of the page which is a static page that prompts the users to recycle and reduce waste to make an impact.

Results

All the techniques and algorithms described in the Methods section were integrated into the project in the order that we wished would provide a smooth sequence and experience to the users for learning about waste management. With multiple different types of interactions users can have with each component of the page, our goal was to engage the users and educate them about the impact they can and should make to reduce waste and why they should do so.

Throughout this project, we wanted to solve the problem of people being irresponsible about waste management. Though difficult to collect data especially during the pandemic, one way we could test how effective our tool was might be to track a group of people who have been exposed to our tool. Though unrelated to our project, a more realistic way to find out the effectiveness of a waste management education program might be for an organization hosting educational programs for a specific school or company to track the amount of waste produced by that school or company before and after the educational program.

Discussion

We provided a tool that users can use to learn the current state of trash around the world and how and why they should and can make an impact to the environment by properly disposing of waste. We wanted to provide a more lasting impression of the waste state by making connections to familiar items such as bulldozers, cars, and dumpsters. As mentioned in the Results section, interactivity was introduced throughout the project to keep users engaged.

Adding images and scales was something that users commented would be beneficial from our minimum viable product. For the last part that tells the story about the benefits of recycling aluminum, a test user said the fact that recycling one month's worth of aluminum cans can result in 1.5 days' worth of oil in the US was shocking and impactful.

From the initial feedback we received, it was a desired feature to be able to compare multiple countries' data side by side. It was also a feature that one of the test users appreciated, saying that it was effective to be able to compare different countries of interest in one view.

Future Work

We could expand this work in many different directions. For example, we only showed the benefits of recycling aluminum in this project, but we can expand to other materials such as plastic. We could also add tools to the page to measure which components users are most likely to interact with the most to measure user engagement.

We could potentially expand this project as an online waste education program, and we could see how the groups of people who went through the program might change their waste disposal habits. We also thought about having users write commitment statements at the end of the lesson, so that they and we can both track how they are doing with their commitments.

Bibliography:

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