Cleanly

Cleanly - Trashducation Urban System

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Abstract
Half the world's population is expected to live in urban areas by 2020. The high human density and changes in peoples' consumption habits result in an ever-increasing amount of trash that must be handled by governing bodies. Problems created by inefficient or dysfunctional cleaning services are exacerbated by a poor personal trash management culture. In this paper we present Cleanly, an urban trashducation system aimed at creating awareness of garbage production and management, which may serve as an educational platform in the urban environment. We report on data collected from an online survey, which not only motivates our research but also provides useful information on reasons and possible solutions for trash problems.

Keywords
trashducation, ubiquitous display environments, public displays, RFID badges, interaction, recycling, design

ACM Classification Keywords
H.5.2 User Interfaces. I.3.1 Hardware Architecture.

General Terms
Design, Experimentation, Human Factors.

Introduction
As the world's population becomes increasingly concentrated in urban areas, and higher living standards in-

Figure 1: Public square in Jerusalem with existing trash bins.

Figure 2: Public square with Cleanly trash bins. Trashcan ID design by Woo Seok Park.

crease consumption, disposal systems become an important infrastructure which merit research. A comprehensive approach focuses not only on transportation and recycling, but also includes additional human aspects, such as low environmental awareness and organizational failures (e.g., bad planning and coverage or worker strikes). In this direction, Strategic Environmental Assessment (SEA) and other frameworks [8] have been applied, including areas such as prevention, recycling, waste treatment and landfill technologies. SEA and sustainable design initiatives seek to ensure a sustainable future for society. However, despite current global efforts, preserving the environment is ultimately dependent on individual and communal ethical values, and how member of society each perceives his or her role [9].

The particular focus of our research is the individual's stake in the problem. We study the issue of increased awareness of the environmental impact of one's waste, and the design of systems to address it. The CHI community has looked into related solutions to create awareness about the energy consumption of infrastructures and their environmental impact [1, 2, 3], and to improve waste management habits [4, 5, 6, 7]. However, most of these projects lack a holistic approach, run short on time, focus on technologies and entertainment, and do not encourage continuous engagement.

The contributions of this paper are as follows: First, we validate our research by presenting results from fieldwork and an online survey. Second, we present a holistic approach called **trashducation**, which is defined as *an effort to educate people in their trash management behaviors by (i) creating awareness of the trash we produce, (ii) lowering its production, and (iii) fostering environmentally friendly behaviors.* Third, we present Cleanly, a trashducation urban system that integrates public displays, wearable devices, and trashcans. Cleanly provides a point for reflection at the individual and community level. It includes mechanisms for the casual trashducant, for prolonged engagements, and for local communities. Cleanly fosters the collective reflection on the habits of a community by presenting relevant local environmental information and user-generated content.

Related Work

Several projects studied awareness of the environmental impact of our existing infrastructures. OneTrees [1] creates awareness of the environmental impact of growing trees in the San Francisco Bay area. Users can follow their growth of 3,000 monitored trees and see how environmental conditions affect them. The project also creates awareness of paper usage by using a printer queue virus that prints out a slice of tree once the equivalent of one tree has been consumed. In a similar way, EcoVisualization [3] examines the energy consumption of a building and makes environmental performance data publicly accessible and easy to understand for everyone. Finally, Imprint [2] extracts data from a printer queue and visualizes it in an effort to support community reflection on paper usage or waste and the resulting conservation measures.

The specific case of waste management has been explored by different projects, including WeighYourWaste [4], which augments a traditional waste bin with electronic weights and calculates the price of disposing the contents for homeowners and companies. Augmented Trash Can [5] is designed for the public space and ex-

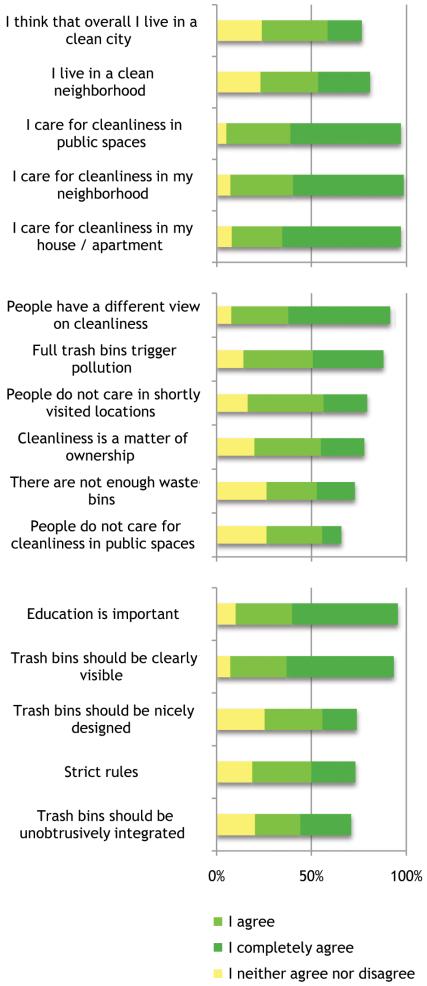

Figure 3: Survey's results (people's view on cleanliness, reasons for trash problems and suggested solutions).

poses the contents of a public waste bin on a floor projection as a way to motivate people to put their trash in the right place. Finally, the Trashcan Arcade and the Trashcan Long-Hole [6][7] projects explore ways of increasing the user experience when throwing the trash in the bin, hence increasing their usage and fostering long-term, environmentally-friendly behavior.

Fieldwork

To get an initial idea of the problems at hand, the main reasons for trash problems, and feasible solutions, we conducted a full day of observation in the city of Jerusalem. We consider Jerusalem to be a suitable starting point for our research because of its multicultural character and the fact that social groups primarily aggregate in planned communities. On one hand - a high number of religious inhabitants that profess Islam, Judaism, and Christianity; on the other hand - Jerusalem, a significant pilgrimage destination that attracts countless tourists throughout the year. These factors allowed us to observe areas with a rather homogeneous population structure (e.g., resident areas in the 'new city') as well as areas frequented by a heterogeneous audience (e.g., tourist areas in the 'old city').

Method

We mainly conducted placed-centered observations at public squares and in random streets of Jerusalem, taking both notes and pictures (Figure 1). We also made sporadic-task observations of people as they disposed of their waste and conducted qualitative interviews with daily commuters and frequent visitors. We were especially interested in their opinions on multiculturalism and tourism, in addition to security and political issues.

Preliminary Findings

Based on the analysis of our observations and interviews, we believe that there are several factors that strongly impact the trash problems.

People have different requirements for cleanliness: We observed that this problem exists both on a micro and macro level. Whereas a certain amount of pollution might be still acceptable for one individual or group, for the other, it is not. When visiting Jerusalem, we noticed that trash problems were especially obvious in the areas that are shared by different social groups (i.e., at the macro level). Similarly, this observation was also evident in settings where individuals with different requirements for cleanliness share the same space (e.g., the same apartment), which represents the micro level.

Cleanliness is related to ownership: We observed that trash problems are more serious in areas where people clearly do not own the houses or apartments, but rather, rent them. We assume that people simply care less if they do not own the property in question.

People do not care for cleanliness in certain areas: During our fieldwork, we determined that certain places tend to get polluted more quickly than others. These areas include public spaces or locations where people only spend a limited amount of time (e.g., tourist locations, stadiums, beaches).

Full trash bins trigger further pollution: We observed that in spaces with full trash bins, people tended to discard their trash around the designated receptacle. However, such did not occur in locations with empty, clearly visible trash bins. We believe that clearly visible

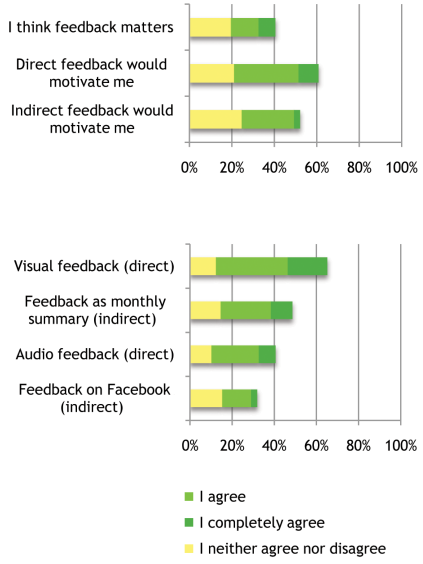

Figure 4: Survey's results.
(Top: People's view on motivation to participate in a trashducation program; Bottom: Users' view on concrete forms of feedback).

and conveniently located trash bins support the preservation of a clean environment.

Though we found that some of the problems were related to the unique setting (i.e., Jerusalem is a cosmo- believe that most of the aforementioned problems are unrelated to a specific place and may be applied to most major cities. To verify our assumptions, we conducted an online survey with a focus on generic problems that could occur in many places around the globe.

Online Survey

To obtain a deeper insight into the trash problem and an indication whether the problems were location-specific or generic, we set up an online survey and collected data during a 10-day period. We distributed the survey among friends, colleagues and students.

Demographics

In total, 138 people (91 men) with an average age of 31.1 years completed the questionnaire. The most common occupations were student (47), employee (37), and researcher (21). Participants were mainly from Germany (60), Israel (51), Denmark (10), and Colombia (5). Most lived in major cities with more than 500.000 (56) or more than 1.000.000 inhabitants (24).

Questions

The survey was separated into four parts and the participants were asked to rate statements on a five-point Likert scale (1 = don't agree at all, 5 = completely agree). First, we were interested in the participant's overall view of cleanliness. Second, we were interested in perceived reasons for trash problems, according to our previous findings. Third, we wanted to know which Fourth, we were interested in determining whether feedback would motivate people to participate in a trashducation program.

Results

The results are depicted in Figure 3 and 4. The values are based on the participants' ratings (3 or above on the Likert scale, where 3=yellow, etc.).

We found out that 52.8% of the participants felt that they live in a clean city and 58.3% believed that they live in a clean neighborhood (4 or 5 on the Likert scale). All participants had a rather high requirement for cleanliness: 92.4% stated that they care much or very much for cleanliness in public spaces, 91.7% in their neighborhood, and 89.6% in their apartment.

Regarding the *perceived reasons for trash problems*, 84.7% of the participants felt that the predominant issue is differences in others' requirements for cleanliness (agree or strongly agree). Full trash bins (74.4%), a low regard for cleanliness in places where people only spend a short amount of time (63.2%), and ownership (56.9%) also carry major impact.

As for *possible solutions to trash problems*, 85.4% of the participants agree (4) or strongly agree (5) that education is important. They also felt that the appearance of the trash cans plays a major role: 86.6% think that trash bins should be clearly visible, 50.0% think that they should be unobtrusively integrated into the environment, and 49.3% think that they should be nicely designed. Only 54.2% of the participants agree or strongly agree that strict rules (e.g., by penalties for littering) might help to solve the trash problem.

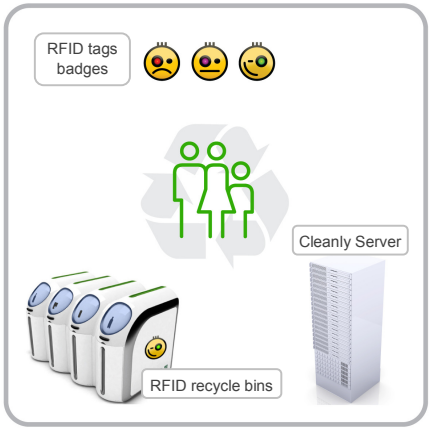

Figure 5: Cleanly artifacts including RFID bins, data server, and badges. Trashcan ID design by Woo S. Park.

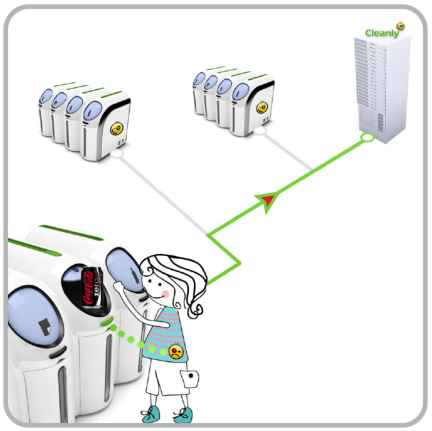

Figure 6: User interaction with Cleanly. Trashcan ID design by Woo Seok Park.

We were also interested in *how to motivate people to participate in programs aimed at solving trash problems*, such as through offering feedback. 52.8% of the participants agree or strongly agree that feedback matters. However, only 40.3% preferred or strongly preferred direct feedback, while 28.5% preferred indirect feedback. When asked about concrete forms of feedback, 51.4% stated that visual feedback, such as a changing smiley face on the bin, would motivate or strongly motivate them to participate, while 27.1% preferred audio feedback. For indirect feedback, only 16.0% thought that feedback via social networks is motivating or strongly motivating, but 35.4% favored a monthly summary of how much trash they collected in comparison to the community average.

Discussion

Despite the high requirement for cleanliness, people are obviously unwilling to take responsibility. While 95% of the people claimed to care about the environment, 65% of them blamed the trash problem on others. This finding, however, merits further study since it can be an instance of disparity between what people say and do. With only 52% of support, it is not clear whether feedback could have a positive impact in motivating people to keep a cleaner environment.

Trashducation

Based on the results from our fieldwork and survey, we define the guidelines of our work in the notion of *trashducation*: trash (i.e., physical garbage/digital recycle bin) + education. We see 'trashducation' as the core value of sustainability technology for urban communities: (i) trashducation solutions *draw the individual's attention to a particular environmental problem* (e.g., inadequate recycling solutions and non-habitual recycling practice), (ii) trashducation systems *encourage day-to-day green behavior on the particular problem*, and (iii) trashducation solutions *endorse proactive thinking about the environment* by 'fashioning' the environmentally friendly processes into a holistically designed solution.

Marshall McLuhan said, *"We shape our tools and then our tools shape us."* Trashducation solutions result from the concerns on the current deterioration of the planet, and we hope those solutions shape and support our future, greener behaviors.

Design of Cleanly

We designed Cleanly as a trashducation system that is aimed at drawing attention to trash management in public spaces. Our system consists of networked trash bins equipped with a touch-enabled public display, plus RFID and Bluetooth interfaces (Figure 5 and 6). This setup allows users to be tracked via their cell phones' Bluetooth MAC address or an intelligent RFID-augmented badge that shows the user's contribution in the community as a smiley face on the badge. The system can build anonymous user models and display information of interest according to location, preferences, and habits. It includes a server for aggregating data and allows users to distribute content through the local public displays in the bins, input their Bluetooth address, order a badge, and see their monthly activity.

Based on an awareness model [9], Cleanly can show personal/community contributions and environmental tips (user's focus) on public displays (nimbus). Hence, Cleanly supports day-to-day engagement by showing and adjusting content based on constructed user models, intelligent dynamic badges, and environmental tips.

We plan to display relevant information about related environmental problems in the local areas.

With Cleanly's design, we take into account the users' concerns by providing attractive and visible bins, and create awareness of both individual and collective efforts. By comparing local efforts with those in other parts of the city, we aim to increase the sense of ownership in public spaces. Further, we support the distribution of educational and user-generated content and provide a backchannel with which to raise environmental concerns.

Cleanly serves as a platform to explore the potential of feedback for solving trash problems that uses dynamic badges, monthly personal reports, adaptive content based on dynamic user and community profiles, comparative information, and public conversations.

Conclusion and Future Work

This paper introduces our preliminary vision of Cleanly, an urban trashducation system, based on joint results of a fieldwork in Jerusalem and an online survey. Our future work will focus on developing a prototype of the proposed system. We plan to follow an urban probes methodological approach [5]: (a) Carry out field studies to identify public zones of intervention. (b) Carry out interventions to help us understand the potential of Cleanly's features. We would like to explore whether the various cultures in Jerusalem react differently to the interventions and determine the most suitable ways to engage them. (c) Enhance Cleanly's design and focus on features supporting collective reflection, such as numerical analysis, bulletin board messages, and content creation and management. And finally (d) Run a large-scale user study to measure the importance and success of trash management education.

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