Smelly Shoes – An Opportunity for Shoe Rack Re-design

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Abstract. One of the prominent roles of ergonomics is to understand, and design lifestyles support system that apart from optimizing human well-being and overall system performance also brings good experience of using any product. This paper is focused on understanding the good experience part of any design, and presents a pilot study conducted to understand how foul smelling shoes affects the good experience of using a shoe-rack. Literature reports many studies concerning the interaction of humans with shoes and shoe-racks, but limited research has been reported on understanding how the foul smelling shoes affects the overall experience of using a shoe rack.

India is a hot and humid country, and people often perspire after medium to rigorous physical activity leading to foul smelling body, clothes, and shoes. People regularly bathe and wash cloths, but shoes are seldom washed, and without proper ventilation it becomes a breeding ground for a very smelly bacterium called Kytococcus Sedentarius.

This paper posits that this foul smell affects the users' experience of using shoe-racks, and reports a pilot study conducted to understand the severity of the problem. The paper starts with a literature review establishing the research gap. It then illustrates on the results of the survey conducted and why existing solutions are not so popular in India. The last part of the paper presents some base experiments conducted which when integrated with the shoe-rack design may eliminate the problem of foul smell and improve the overall experience of users.

Keywords: Shoe-rack, Shoe Odor, User Experience, Ergonomic Evaluation

1 Introduction

Ergonomics as a scientific discipline is mainly concerned with understanding the interactions among humans and other elements of a system, and to design in order to optimize human well-being and overall system performance. This includes designing tasks, objects, machines, jobs, environments, processes and systems that are usable, effective, efficient, healthy and safe [1]. Apart from these, users' experience is a parameter which is often missed by ergonomist. This paper is focused on understanding the good experience part of any design, and presents a pilot study conducted to understand how foul smelling shoes affects the good experience of using a shoe-rack.

India is a hot and humid country leading to perspiration after medium to rigorous physical activity. Without proper ventilation, and lack of washing, shoes become a breeding ground for a very smelly bacterium called Kytococcus Sedentarius (formerly

Micrococcus Sedentarius) [2]. This awful smell become dominant in a closed environment like a shoe-rack, and is likely to affects the users' experience. Following section presents a review of literature concerning the ergonomics of shoe-rack design.

2 Ergonomics of Shoe-rack Design – A Literature Review

A narrowed-down search of various ergonomics related databases yielded very few results on shoe-rack design. Review of two such researches which were found relevant and closest to the presented research is elaborated in the following paragraphs.

Sanjog et al. (2012) suggested that most of the shoe racks available in the market need to be evaluated on ergonomic criteria to improve their usability. Their paper recognized multipurpose use, usable by all the family members (of varying age group starting from kids to grandparents), visibility of all the shoes in standing position, easy to move, provision of sitting space for tying the laces, easy to clean, aesthetically pleasing, protection from dust and moisture, and safe to use as must features for any shoe-rack design [3]. The paper demonstrated how conceptual shoe-rack designs can be evaluated for various human factor aspects in 3D-CAD environment using DELMIA software with digital manikins. An analysis with respect to vision, reach, and posture (shoe lace tying/untying) was carried out on the conceptualized design to find out its suitability for the intended user population. Owing to the lack of data and limitation of the software, evaluation was not carried out for old age and children.

Ming & Ng, (2015) study is focused on the usability evaluation of existing conventional type shoe-rack designs in Malaysian context, and explore the prevalent types of musculoskeletal injuries and discomforts. Markey survey revealed that the customers were inclined towards buying an eco-friendly, multi-purpose and space saving shoe-rack. Based on the exploration, an automated shoe rack was proposed with improved usability features. The proposed design was evaluated with anthropometric data of Malaysian in 3D-CAD environment using DELMIA human modelling software (version 5.19). The design was finally prototyped using locally available materials, and the REBA (Rapid Entire Body Assessment) usability test was conducted [4].

In the presented literature review, it was observed that most of the discussion was focused on the physical aspect of ergonomics (like musculoskeletal injuries and discomfort) of shoe-rack design. This indicates a lack of understanding on the users' experience of using a shoe rack. The presented paper posits that apart from the ergonomic criteria, experience of users while interacting with the shoe-rack is equally important. It matters if shoe rack smells bad when a user interacts with it. Having a foul smelling shoe rack indoors has a high chance of carrying that foul smell inside the house and may not be desirable. To comprehend the problem better, a pilot study was conducted, reported in the following section.

3 Prevalence of the Problem – A Pilot Survey

Lack of study towards understanding the prevalence of the smelly shoe problem, and its implications on users' experience led us to conduct a pilot study. The instrument

used for the exploration was a questionnaire, designed using the online service of google forms (available at https://goo.gl/iFNJSS). A total of 21 questions where designed to collect user responses pertaining to their various requirements and preferences. Some questions were put indirectly to understand the true priorities of the user, while for other questions Likert scale of 1-10 was used for rating.

The data was collected from a total of 149 first year students of Shiv Nadar University (SNU), Uttar Pradesh. These students can be considered representative populations as state wise student demography is kept unbiased at SNU.

3.1 Results and Inferences

Out of the total 149 responses, 80% were male and 20% were females, with an average age of 18 years. Following were the major results and inferences of the study.

a. Majority of respondents (54.6%) feel uncomfortable around others because of foul smell from their shoe.
b. About 52.4% of the people experienced an embarrassing situation when they have to leave the place because of someone else foul smelling shoe.
c. When asked about the methods they adopt when their own shoe smell bad, 44.3% said that they wash them, 38.3% dry them in sun and the rest put tea bags in shoes, sprinkle baking soda, sprinkle antibacterial powder, some of them spray deodorants on shoes and a few prefer buying new pair of shoes.
d. When images of available products (for smell prevention) in market were shown to them, 88% of them have never seen any of the products before.
e. Majority of the people were not satisfied with the current solution and are keen to buy a new product which solves the problem. Figure 1 show how likely the participants were in buying a new product which solves the problem (1 being most likely, 10 being least likely).

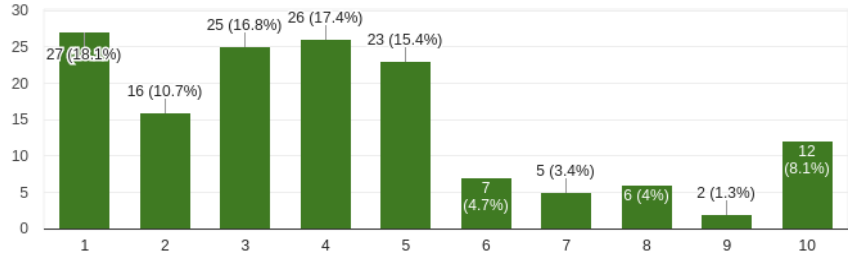

Fig. 1. Likeliness of the respondents in using a new product which solves the problem.

f. When asked about where they usually keep their shoes after use, 90% said that they prefer putting their shoes in shoe rack.
g. When asked about the total pair of shoes they own, average number of shoes came out to be 4 pair. Data also suggest that they frequently use 2-3 pairs.

From the presented pilot study it was inferred that majority of the people face the problem of smelly shoes, and there is a lack of popular remedy. Also, majority of the population believe in washing (which damages the shoes) the shoe or drying it in sun. Study also reveals a lack of awareness about the available products in the market. Fol-

lowing section attempts to explore the available solutions, and products for solving the foul smell problem.

4 Existing Solutions – Market Survey

Although there is a lack of well-designed scientific research demonstrating effective remedy against smelly shoes, following recommendations were found.

a. Tea tree oil and coconut oil are effective against fungal infections and are recommended for smelly feet [5].
b. Thyme oil has been proved to be a good inhibitor of fungi conferred by high thymol and/or carvacrol content and prevents shoe odor [6].
c. Sanitizing footwear with ozone has been found to suppress the propagation of bacteria and one such device have been patented [7].
d. Using isopropyl alcohol in strengths of 70 to 99 percent, and salt over the interior of the shoe was found to be effective [5].

Table 1: Existing products in the market for smelly shoes

Product Image	Price (INR)	Customer comments
	300	Dries shoe gently. Removes odor. Takes up to 24 hours
	8000	Works great, gets rid of bacteria in shoes and helps eradicate the smell. Lifetime of product is very less.
	9000	This really works well on killing the odor Lifetime of product is less.
	3840	Effective and does the job and quickly. The device is such that it will stretch the shoes.
	1980	Very convenient and effective in killing odor/bacteria and gets the job done. Bulb life is low and is irreplaceable.

Apart from these remedies, there are few products in the market which claims to solve the problem by either disinfecting or sanitizing the shoes. Table1 illustrates few such products along with customer comments derived from the online customers re-

view. Customer review indicated that most of the people do not have faith in such devices, and they find it of limited use as they are designed to work with only a single pair of shoe at a time.

5 Shoe-rack for Smelly Shoes

Market survey did not yielded any product which was designed keeping into consideration the total number of shoes in the household. None of the devices are integrated with the shoe-rack, where people store their shoes. In India, almost every household have a shoe rack of one type or the other, and having a shoe-rack which keeps the shoes smell free would give a great experience. The authors of this paper see smelly shoes as an opportunity for re-designing the traditional shoe-rack for a better user experience. After exploring all the possible methods of killing the bacteria which was the main source of smell, use of Ultra Violet rays was chosen to be a potential method. In an attempt to design such a shoe-rack base experiments were conducted, experimental set-up of which is illustrated in Figure 2.

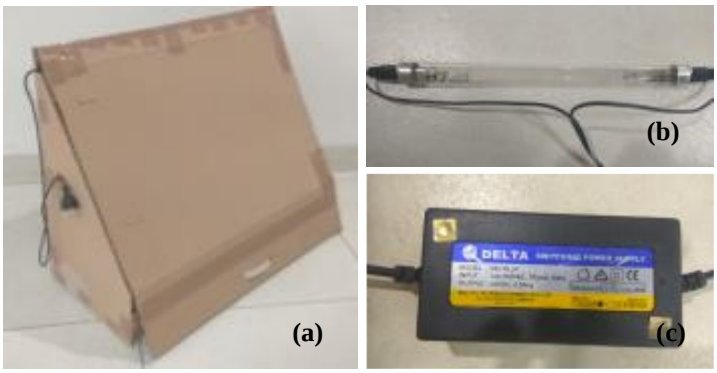

Fig. 2. Experimental set-up (a) cardboard enclosure (b) UV-C tube light (c) SMPS

For our experiment, shoes of SNU athletes were used which had a very strong noticeable odor. A UV-C tube light (Wavelength 270 - 280 nm) was used with switch mode power supply (SMPS). An electronic choke is used to convert the 24V DC from SMPS to high-voltage which is then applied to UV-C tube light (11W power rating). Entire experimental setup was enclosed in a cardboard enclosure to avoid any direct exposure to the eyes. Since, maximum bacteria are accumulated near the toe of the shoe; UV-C light was set accordingly. Table 2 shows the exposure time (in mins), and odor detected. The aim of the experiment was to approximate the exposure time for getting rid of foul smell due to bacteria. The odor was rated on a scale from 1 to 5, where 5 being the strongest and zero being not detectable.

Table 2: Exposure time of UV-C tube light and odor observed

Exposure (in min)	Foul Smell from Shoes	Smell due to UV treatment	Observation
0	3.5	0	Strong pungent smell, rotten cheese like smell.
2	0.5	0	Extremely low foul smell, Mild burnt rubber smell
4	0	1	No foul smell, average burnt rubber smell
6	0	3	No foul smell, burnt rubber smell, shoe not hot
10	0	3.5	No foul smell, Strong burnt rubber smell
15	0	4	Very stronger burnt rubber smell, Shoe hot

As evident from the Table 2, an exposure of 2-3 mins is sufficient to kill the bacteria and cure the foul smell.

6 Conclusion

The presented paper posits that the foul smell from shoes significantly affects the users' experience of using a shoe-rack. Literature review showed that ergonomists generally focuses only on the physical aspect (like musculoskeletal injuries and discomfort) of shoe-rack design, and users' experience part is often missed. The pilot study reported here revealed the severity of the problem, and the need of an improved product. The paper proposes a shoe-rack fitted with UV-C tube light and reports base experiments to measure the exposure time of 2-3 mins.

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Series Title:

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Springer

Title of Book/Volume/Conference: Humanizing Work and Work Environment (HWWE) 2017

Editor(s) name(s):

Title of Contribution: Smelly Shoes – An Opportunity for Shoe Rack Re-design

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