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An Assessment Study For Improving The Sound-Shape Correspondence For Architectural Hardware Lever-Handles Using Generative AI

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Abstract: Lever handles are an important product category in architectural hardware. It is a challenging to conceptualize and its design has been popularly undertaken by many famous designers. Surface level aesthetics as well as the semantic meaning are vital concerns when designing lever handles. Here, sound-shape correspondence is an important determinant of the appropriateness of semantic fit between a product name and its form. In this study, 5 handle designs were assessed for the extent of their sound-shape correspondence by 21 university-level undergraduate design students. Then, using ChatGPT 4o and Midjourney tools, new handle designs were generated to semantically represent the original handle names. These new designs were also assessed for the extent of their sound-shape correspondence. Finally, the correspondence values of original and new handle designs were compared using paired-sample Student's t-test. Only 1 original handle form was found to have "good correspondence" with its actual name (Dana). However, all the 5 new handle designs were found to have "good correspondence" with their corresponding names (i.e. Axor, Dana, Primo, Torso, Zenith). It was found that the average ratings of correspondence between all the new handle designs and their original names were higher than that of the original designs. This difference was found to be statistically significant as well ($p < 0.05$). An important observation was that out of the 5 handles, the original design of Zenith was found to have good correspondence with 4 out of the 5 handle names; original Dana with 3 out of the 5, and new Axor with 3 out of the 5 handle names.

In the results, certain sound-shape perceptions were perceived better than the others. Importantly, it was established that the use of generative AI tools augmented with expert human decision making could be successfully used as a process to conceptualize product designs with good sound-shape correspondences.

Index Terms – Sound-shape correspondence, lever handle, architectural hardware, generative AI.

I. INTRODUCTION

In India today, consumers have fairly high expectations from products. There is a wide array of choices available before them and very often consumers expect to, and like to visualize a wide range of design options before committing to purchasing a specific one. One important and fast-growing segment of consumer and industrial goods is architectural hardware [1]. Architectural hardware plays a pivotal role in the functionality, aesthetics, and overall experience of a building. These elements, often overlooked, include door handles, locks, hinges, and other fittings that are integral to both the interior and exterior of structures. Beyond their practical utility, architectural hardware contributes to the building's design language, affecting how occupants interact with the space. Architecture, as the most tangible and dominant of the arts, surrounds us constantly—yet, intriguingly, our physical interaction with it is limited to just a few points, for e.g. a handrail, a light switch, and almost inevitably, the door handle. This unassuming, handheld element serves as our essential connection with the building's structure and materials [2].

1.1 Lever Handles

Lever handles are a type of door hardware commonly used in residential, commercial, and institutional buildings. They are an alternative to the traditional round doorknob and are especially popular in environments where ease of use and accessibility are important.

In designing the lever handle, designers typically focus on conceptualizing the following features [3] –

1. Lever handle (lever arm): the main bulk of the product and the part your hand wraps around to operate the handle.
2. Cover rose or escutcheon: A plate that surrounds the base of the lever, covering the installation hole and adding a finished look.
3. Return: the usually 90° angle where the lever grip turns and fixes into the rose.

In most designs, the lever arm and the return are generally conceptualized together as a single continuous monolith component. Also, while the designs of the lever arm and the return may be highly varied, only a few standard designs of the rose plate are produced for the handle base. It is a common practice therefore that the major focus of industrial designers remains on design of the lever arm and return, and the rose plate meets less frequent industrial design intervention.

Designing lever handles involve considerations of both – the surface level aesthetics, as well as the aspects of design semantics and meaning. Design semantics is the annotation of form and the reflection of its symbolic meaning, which means it is an explanation of the deposited human cultural spirit [4]. At its core, design semantics considers products as a language composed of shapes, colors, textures, materials, and associated elements [5-6]. There are many commonly available resources that describe the surface level concerns of aesthetics when designing lever handles, for e.g. [7-8]. However, the concerns for design semantics are rarely discussed and are often more challenging to address [9]. One reason for this could be that the semantic concerns could be different and unique to a form and context. Also, the concerns for semantics are typically richer in information than the concerns of pure surface level aesthetics. Therefore, during its design, each distinct version of product form could require an independent, careful and deliberate semantic analysis. This exercise could help with, for e.g. its meaningful classification. It is in this regards that an important semantic consideration in new product development is assigning an appropriate name to a product model.

1.2 Sound-shape correspondence

In industrial design, the relationship between the sound of a product's name and its physical shape plays a crucial role in how consumers perceive, interact with, and remember the product. This phenomenon, known as sound-shape correspondence, suggests that the phonetic qualities of a word can evoke specific visual and tactile associations, making the alignment between a product's name and its form a powerful tool in design [10-11].

Sound-shape correspondence is a subtle but powerful element of design that taps into the innate cognitive and emotional associations we make between sounds and forms. By thoughtfully aligning a product's name with its physical attributes, designers can create products that are not only more intuitive and memorable but also emotionally resonant. This alignment not only enhances the user experience but also strengthens brand identity, making it an essential consideration in product design.

When a product's name phonetically aligns with its shape, it becomes more intuitive to users. For instance, a product named "Blade" is likely expected to be sharp and angular, while a name like "Cushio" would suggest a soft, rounded form. This alignment reduces cognitive load, making the product easier to understand and use. It could also be observed that the emotional resonance of a product is often heightened by sound-shape alignment. A product like "Snuggle," for example, evokes warmth and comfort, which is mirrored in its soft, rounded design and contributes to a deeper emotional connection with users (Fig. 1(a)) [12]. In the example of Lush Bath Bombs, the name "Lush," with its soft consonants and vowels, aligns perfectly with the product's round, smooth shape, evoking a sense of luxury and indulgence (Fig. 1(b)) [13].

Fig. 1(a): Snuggle fabric softener packaging [12].

Fig. 1(b): Sample pieces of the Lush bath bombs [13].

1.3 Generative AI and design

Generative AI tools based on Large Language Models (LLMs) are increasingly finding applications beyond natural language processing, extending their generative capabilities to industrial design. These AI systems leverage vast amounts of data and advanced algorithms to assist designers in creating innovative products, optimizing design processes, and enhancing creativity. Tools like ChatGPT, powered by OpenAI's GPT-4, can generate design ideas, suggest materials, and even predict potential design trends based on input prompts. Designers can input specific requirements or constraints, and the AI can generate multiple concepts or iterations, offering inspiration that might not have been considered otherwise [14].

MidJourney is another popular generative AI tool that generates detailed and high-quality images from textual descriptions, enabling designers to rapidly visualize and iterate on product concepts. The tool is particularly effective in helping designers explore diverse design possibilities by quickly generating different styles, materials, and forms, which are crucial in the early stages of the design process [15].

1.4 AIM

The aim of this research is to –

1. Conduct a survey to analyse lever handle designs to assess their sound-shape correspondence.
2. Use generative AI to propose new handle designs for the given handle names, and assess their sound-shape correspondence.
3. Compare the sound-shape correspondences between the original and new handle designs, with the handle names as a constant.

II. MATERIALS AND METHODS

The following steps were followed in this research-

i. Five industrial designers were contacted for volunteering in this study. Their contribution was requested in analysis and decision making during the study. The two experts who responded first, were recruited for the research. The designers each had more than 10 years of experience in industrial design research and practice.
ii. The designers were first required to catalogue a set of 5 lever handle designs developed by a single manufacturer. Clear images of these handles in perspective view, their names and descriptions were documented.
iii. Thirty final year students, studying Design at a local university were contacted to volunteer for this study as respondents to a sound-shape correspondence survey. Twenty-one students agreed to participate.
iv. The 21 participants were shown the names and images of the 5 handle designs and asked to assess the sound-shape correspondence between each pair. The image of each handle was printed on cardstock paper of size 4 in x 4 in.
v. Each of the 5 handles was assessed for the correspondence with each of the 5 names. They were asked to indicate on a rating scale of 1-9, the extent of sound-shape correspondence (where 1 = the shape has zero, or no correspondence to the handle name at all; 5 = the sound-shape correspondence is average or medium; 9 = this shape has an extremely high, or perfect correspondence to the handle name).

vi. The experts and the author then used the handle names to generate new designs for these handles using the ChatGPT 4o and Midjourney generative AI tools. Here, the handle name was used as the key input prompt for generating a relevant design. Four handle design options were generated for each handle name. The 2 experts analyzed the options which were generated. They assessed and selected the most appropriate design option for a handle name as representing the new design proposal.
vii. Now, the 21 design students assessed the 5 new designs and their names for the sound-shape correspondence.
viii. The original and new sound-shape correspondences were compared using a paired sample t-Student's t-test [16].
ix. Finally, the experts and the author analyzed and discussed the most relevant findings from the study.

With regards to experiment design, a major decision was taken with regards to the nature of stimuli. Since the subjective perceptions could become fairly complex with visual experiences of color, it was decided that they may merit a separate and focused research study. Therefore, in this research, the handle design images used as stimulus were in grayscale, desaturated of all the hue information.

III. RESULTS AND DISCUSSION

The 5 handles selected for this research study have been shown in Figure 2. The experts justified their choice by claiming that these models covered the most varied categories of designs in the product range offered their manufacturer [17].

Fig. 1: Original handle designs [17].

Codified reference names (O1-O5) were proposed for these handles by the author for easy reference during this study (see Figure 2 & Table 1). It was also felt that referencing these handles by an abstract indexical code would ensure that the design student participants stay unaware of the actual names. This could improve the chance of eliciting unbiased responses during the survey. As handle design descriptions could provide an important sense of the design and marketing priorities of the manufacturer [18], the exercise was performed with the 5 lever handles as well. The indexical names, actual names and manufacturer website descriptions of the 5 handles have been documented in Table 1.

Table 1: Handle names, reference names and handle descriptions [17].

Handle design code	Handle name	Handle description by the manufacturer [17]
O1	Axor	An ode to falling water, curved steel with luminous presence; strength & details uncompromised.
O2	Dana	Organic form of a bow like shape forming the grip of lever, culminating elegance in a oval form like a water droplet.
O3	Primo	Exuding strength & comfort of a contemporary philosophy, Primo easily camouflages into any color scheme in a modern design.
O4	Torso	A sculpted body shape that transforms into an object of our daily needs. This design celebrates the beauty of nicely carved and sculpted body forms in surroundings around.
O5	Zenith	With curled lines diverging from a central pivot, Zenith lives its name by conveying a striking design statement; imparts a fresh inspiration to a space

The mean and standard deviation values of the sound-shape correspondence ratings of the handle names and their original designs have been documented in Table 2. The author and the experts agreed to consider any rating value of "4 and above" as case of a "good correspondence" between the handle shape and name. These cases from the results have been bold-italicized in Table 2. It can be seen that according to the design students, the original handle shapes and their original names (showing along the O1-Axor-O5-Zenith diagonal of the table), correspond well only for one case – i.e. Dana. The design O1 had "good correspondence" with 4 of the 5 handle names; O2 with 3 of the 5; and O1 with 2 of the 5 handle names.

Table 2: Sound-shape correspondence ratings for original handle forms.

Original handle designs (shape)	Handle names (sound)				
	Axor	**Dana**	**Primo**	**Torso**	**Zenith**
O1	M(O1)=3 SD(O1)=0.63	M(O1)=2.95 SD(O1)=0.92	***M(O1)=6.19*** ***SD(O1)=0.51***	***M(O1)=5.09*** ***SD(O1)=0.88***	M(O1)=2.28 SD(O1)=0.71
O2	M(O2)=2.23 SD(O2)=0.83	***M(O2)=5.19*** ***SD(O2)=0.81***	***M(O2)=5.04*** ***SD(O2)=0.97***	M(O2)=2.71 SD(O2)=0.71	***M(O2)=4.23*** ***SD(O2)=0.7***
O3	M(O3)=2.90 SD(O3)=0.62	***M(O3)=4.76*** ***SD(O3)=0.83***	M(O3)=2.90 SD(O3)=1.13	M(O3)=3.19 SD(O3)=0.75	M(O3)=2.90 SD(O3)=0.54
O4	***M(O4)=4.09*** ***SD(O4)=0.89***	M(O4)=3.09 SD(O4)=0.78	M(O4)=3.23 SD(O4)=0.7	M(O4)=3.09 SD(O4)=0.62	M(NO4)=3.09 SD(O4)=0.7
O5	***M(O5)=5.23*** ***SD(O5)=0.9***	***M(O5)=6*** ***SD(O5)=1.09***	***M(O5)=4.04*** ***SD(O5)=0.74***	***M(O5)=6.09*** ***SD(O5)=0.83***	M(O5)=1.95 SD(O5)=0.59

3.1 New handle designs

The following textual prompt was used to generate new designs for the 5 handle names -

Propose appropriate, relevant visual designs using principles of sound-shape correspondence of an architectural hardware, a level door handle with the name as AXOR <handle name>. The handle should be made of brass with grey satin nickel finish on the surface. The compositional background needs to be white, and there should be nothing else in the background. The semantic essence of the handle name should be clearly experienced by looking at the design. Do not introduce any irrelevant details in the rendering. The product should be presented in perspective view.

Under each of the 5 handle names, the most appropriate handle design selected by the experts has been represented in Figure 3.

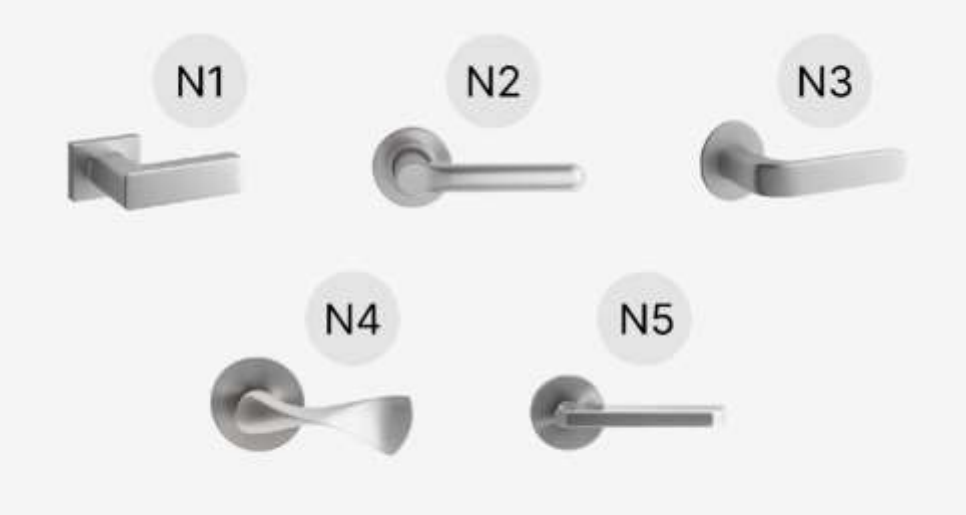

Fig. 3: AI generated new handle forms.

The mean and standard deviation values of the sound-shape correspondence ratings of the handle names and their new designs have been documented in Table 3. It can be seen that according to the design students, for all the 5 cases (showing along the diagonal of the table), the new designs and their names have "good correspondence". The design N1 has good correspondence with 3 of the 5 handle names; N2, N4 & N5 with 2 of the 5 new handle names.

Table 3: Sound-shape correspondence ratings for AI generated new handle forms.

New handle designs (shape)	**Handle names (sound)**				
	Axor	**Dana**	**Primo**	**Torso**	**Zenith**
N1	***M(N1)=4.95 SD(N1)=1.02***	M(N2)=3.19 SD(N1)=1.07	M(N1)=2 SD(N1)=0.63	***M(N1)=5.42 SD(N1)=1.39***	***M(O1)=4.09 SD(N1)=1.22***
N2	M(N2)=3 SD(N2)=0.71	***M(N2)=6.33 SD(N2)=0.96***	***M(N2)=4.95 SD(N2)=0.8***	M(N2)=3.09 SD(N2)=0.83	M(N2)=2.90 SD(N2)=0.83
N3	M(N3)=2.85 SD(N3)=0.57	M(N3)=2.76 SD(N3)=0.76	***M(N3)=5.19 SD(N3)=0.93***	M(N3)=1.85 SD(N3)=0.57	M(N3)=3.90 SD(N3)=1.09
N4	***M(N4)=4.04 SD(N4)=0.67***	M(N4)=2.90 SD(N4)=0.77	M(N4)=2.09 SD(N4)=0.62	***M(N4)=5.95 SD(N4)=1.36***	M(N4)=1.81 SD(N4)=0.51
N5	***M(N5)=5 SD(N5)=1.41***	M(N5)=2.85 SD(N5)=0.73	M(N5)=3.95 SD(N5)=0.94	M(N5)=1.85 SD(N5)=0.47	***M(N5)=4.85 SD(N5)=1.15***

3.2 Old vs. new handle design comparison

A paired sample Student's t-test was conducted to compare the perceptual ratings of the sound-shape correspondence between the original and new handles (see Table 4).

Table 4: Results of a t-test between correspondence ratings of the original and new handle designs.

Handle designs (shape)	**Handle names (sound)**				
	AXOR	**DANA**	**PRIMO**	**TORSO**	**ZENITH**
O1 vs. N1	**M(N1)=4.95 SD(N1)=1.02 M(O1)=3 SD(O1)=0.63 t(20)=2.08 p < .001****	M(N1)=3.19 SD(N1)=1.07 M(O1)=2.95 SD(O1)=0.92 t(20)=2.08 p = .48	**M(N1)=2 SD(N1)=0.63 M(O1)=6.19 SD(O1)=0.51 t(20)=2.08 p < .001****	M(N1)=5.42 SD(N1)=1.39 M(O1)=5.09 SD(O1)=0.88 t(20)=2.08 p = 2.08	**M(O1)=4.09 SD(O1)=1.22 M(N1)=2.28 SD(O1)=0.71 t(20)=2.08 p < .001****
O2 vs. N2	**M(N2)=3 SD(N2)=0.71 M(O2)=2.23 SD(O2)=0.83 t(20)=2.08 p = .003****	**M(N2)=6.33 SD(N2)=0.96 M(O2)=5.19 SD(O2)=0.81 t(20)=2.08 p = .001****	M(N2)=4.95 SD(N2)=0.8 M(O2)=5.04 SD(O2)=0.97 t(20)=2.08 p = 0.73	M(N2)=3.09 SD(N2)=0.83 M(O2)=2.71 SD(O2)=0.71 t(20)=2.08 p = 0.11	**M(N2)=2.90 SD(N2)=0.83 M(O2)=4.23 SD(O2)=0.7 t(20)=2.08 p < .001****
O3 vs. N3	M(N3)=2.85 SD(N3)=0.57 M(O3)=2.90 SD(O3)=0.62 t(20)=2.08 p = 0.82	**M(N3)=2.76 SD(N3)=0.76 M(O3)=4.76 SD(O3)=0.83 t(20)=2.08 p < .001****	**M(N3)=5.19 SD(N3)=0.93 M(O3)=2.90 SD(O3)=1.13 t(20)=2.08 p < .001****	**M(N3)=1.85 SD(N3)=0.57 M(O3)=3.19 SD(O3)=0.75 t(20)=2.08 p < .001****	**M(N3)=3.90 SD(N3)=1.09 M(O3)=2.90 SD(O3)=0.54 t(20)=2.08 p < .001****
O4 vs. N4	M(N4)=4.04 SD(N4)=0.67 M(O4)=4.09 SD(O4)=0.89 t(20)=2.08 p = 0.85	M(N4)=2.90 SD(N4)=0.77 M(O4)=3.09 SD(O4)=0.78 t(20)=2.08 p = 0.48	**M(N4)=2.09 SD(N4)=0.62 M(O4)=3.23 SD(O4)=0.7 t(20)=2.08 p < .001****	**M(N4)=5.95 SD(N4)=1.36 M(O4)=3.09 SD(O4)=0.62 t(20)=2.08 p < .001****	**M(N4)=1.81 SD(N4)=0.51 M(NO4)=3.09 SD(O4)=0.7 t(20)=2.08 p < .001****
O5 vs. N5	M(N5)=5 SD(N5)=1.41 M(O5)=5.23 SD(O5)=0.99 t(20)=2.08 p = 0.57	**M(N5)=2.85 SD(N5)=0.73 M(O5)=6 SD(O5)=1.09 t(20)=2.08 p < .001****	M(N5)=3.95 SD(N5)=0.94 M(O5)=4.04 SD(O5)=0.74 t(20)=2.08 p = 0.75	**M(N5)=1.85 SD(N5)=0.47 M(O5)=6.09 SD(O5)=0.83 t(20)=2.08 p < .001****	**M(N5)=4.85 SD(N5)=1.15 M(O5)=1.95 SD(O5)=0.59 t(20)=2.08 p < .001****

As discussed earlier, in this study, a sound-name correspondence rating of 4 or higher was considered as "good correspondence". Such cases (ref. Table 2-4), have been plotted in a graphical format in Figure 4. The original handle designs have been represented in black circular discs, and the new handle designs in white-colored discs. The radial size of any circle represented in Figure 4 is proportional to the intensity/level of sound-shape correspondence. That is to say that the designs represented in larger discs are on an average rated higher on sound-shape correspondence than the ones in smaller discs.

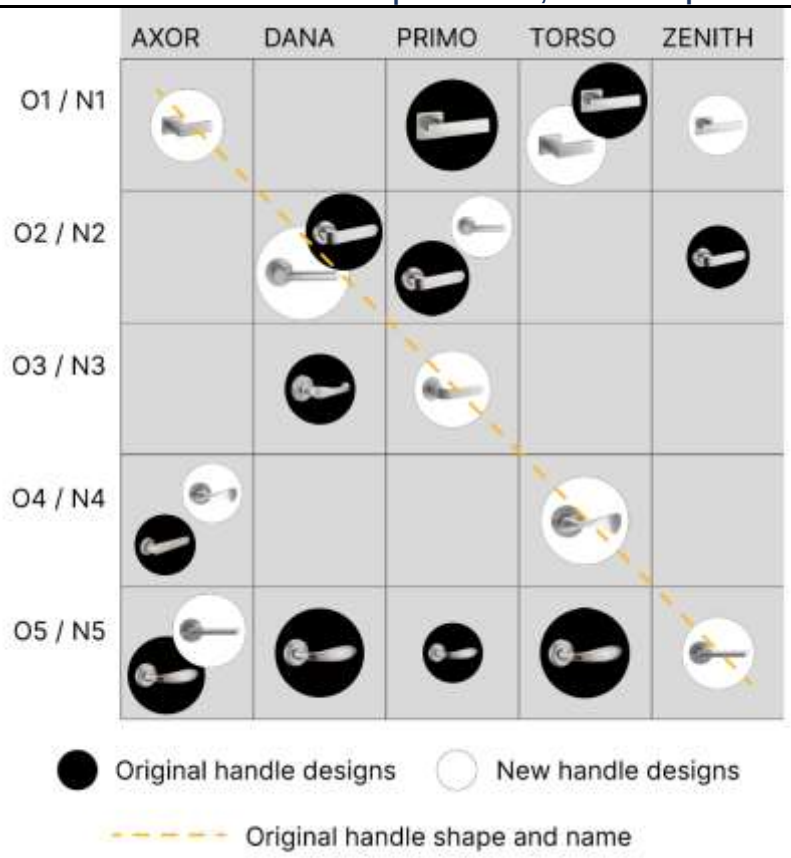

Fig. 4: Representation of high name-shape correspondences.

IV. REFLECTION AND INFERENCES

At the end of the study, the author and experts had a session to discuss and reflect upon the outcomes from the research. The intent was to examine if there were any significant inferences which could not be read directly from the results. A few outcomes were identified and have been shared here.

An important observation was that a few handle shapes have high correspondences with multiple handle name sounds (Fig. 4). If seen as a problematic, this might be perceived as a situation of ambiguity for designers - especially, in case the expectation was to develop distinct designs with fairly unique semantic associations. But, when seen positively, this could be assessed as a case where this widely mapped handle shape is well suited, and could be used under a variety of names. The case of multiple good correspondences for a shape might also be indicative of the relatively generic, or fairly complex nature of the handle design. In the context of architectural hardware, such a design could find use especially in public buildings and sites, where the design needs to cater to the expectations and preferences of a large number of people. In public buildings, another value that a semantically generic or complex looking handle design might provide is that – because the shape may signify multiple ideas, it may not capture too much attention against its background. This could very well serve a specific design intent with the handle.

Also from the results, it was clear that the use of generative AI tools led to improving the sound-shape correspondence for lever handles. At the same time, for this study it is important to acknowledge that this process of AI-based generation was being managed by expert designers. The experts were also tasked to take the final call and select the most appropriate option for the new handle out of the different handle concepts generated. But in an overall assessment, the author and the experts realize that even with human intervention, the generative AI based concept design process was significantly faster, and more productive as compared to the traditional concept design process.

V. CONCLUSION

This research was conducted to survey and analyze the sound-shape correspondence of a range of lever handles and their model names. The assessment was made by 21 university-level design students. Using generative AI tools of ChatGPT 4o and Midjourney, new designs were developed for the 5 handle names. Against each name, 4 concepts were generated and the most appropriate design among these was selected by the experts. New handle designs were again evaluated for sound-shape correspondences. Finally, the original and the new handle design sound-shape correspondence ratings were compared.

It was found that 4 out of the 5 original handle designs were rated poorly in their sound-shape correspondence (Table 2). But, all the 5 new handle designs conceptualized using the generative AI tools were found to have good correspondence to their names (Table 3). Also, a statistically significant difference ($p < 0.05$) between the sound-shape ratings for the new and old handles was observed. The original design of the handle model Zenith (O5) was found to have good correspondence not just with its actual name but in all with 4 of the 5 handle names (Table 2). Also, the original design of Dana (O2) had good correspondence with 3 out of the other 5 handle names. Similarly, among the new handle designs, the design of Axor (N1) had good correspondence with 3 out of the 5 handle names (Table 3). The researchers concluded that the reason for certain handle designs to have good correspondence with multiple handle names might be the highly generic, or fairly complex nature of their designs.

A clarification which is merited towards the end of this article is that the low sound-shape correspondence reported in the results for specific handle designs is based on the assessment by the 21 survey candidates in this study. The results from this study do not imply that the handle designs with low sound-shape correspondence are poor, nor that the products are unsuccessful. Instead, it is important to reiterate that the focus of the study is specifically on the assessment of sound-shape correspondence. What is more relevant, and is importantly indicated through this study is that in the present day, sound-shape correspondence could be successfully implemented with the help of generative AI tools and expert curation by professional designers. Since the semantic assessments could be subjective across population groups, the assessment results may also vary if the study is conducted with a different population set. A possible next step to this research could be to explore the different reflections and inferences made for the observations in this research, as proposed in Section 4.

REFERENCES

[1] https://www.imarcgroup.com/architectural-hardware-market as seen on 3-Sep-2024.
[2] https://www.apollo-magazine.com/history-door-handle-designs as seen on 3-Sep-2024.
[3] https://doorcontrolsdirect.co.uk/blog/post/135-parts-of-a-door-handle-push-on-rose-lever-handles as seen on 3-Sep-2024..
[4] Nie, H., & Zhang, S. (2014). Research on Application of Design Semantics in Space Environment. IERI Procedia, 9, 94-101.
[5] Rambardhan, K., & Bisht, D. S. (2021, December). A User-Centered Comparison of Novelty and Typicality in Product Designs Using Pictorial and Augmented Reality (AR) Representations. In International Conference of the Indian Society of Ergonomics (pp. 983-992). Cham: Springer International Publishing.
[6] Balaji, A., & Bisht, D. S. (2020). Design evaluation of cars taillights in India based on novelty and typicality. In Innovative Product Design and Intelligent Manufacturing Systems: Select Proceedings of ICIPDIMS 2019 (pp. 293-301). Springer Singapore.
[7] https://formani.com/inspiration/news-and-blogs/Top-10-trends-in-door-hardware-for-2024 as seen on 3-Sep-2024.
[8] https://doorsapart.com.au/what-are-the-door-handle-trends-in-2024 as seen on 3-Sep-2024.
[9] Bisht, D. S. & Jaiswal, A. (2024). A semantic analysis of symbiosis inspired built forms in architectural design. International Journal of Creative Research Thoughts (IJCRT), 12(8), e81-e86. http://doi.one/10.1729/Journal.41157.
[10] Wu, T. Y., & Lee, A. (2018). The study of sound and shape effects on design. In Advances in Neuroergonomics and Cognitive Engineering: Proceedings of the AHFE 2017 International Conference on Neuroergonomics and Cognitive Engineering, July 17–21, 2017, The Westin Bonaventure Hotel, Los Angeles, California, USA 8 (pp. 123-130). Springer International Publishing.

[11] Flumini, A., Ranzini, M., & Borghi, A. M. (2014). Nomina sunt consequentia rerum–Sound–shape correspondences with every-day objects figures. Journal of memory and language, 76, 47-60.
[12] https://www.snuggle.com/ as seen on 3-Sep-2024.
[13] https://www.nytimes.com/wirecutter/reviews/best-bath-bombs/ as seen on 3-Sep-2024.
[14] https://openai.com/ as seen on 3-Sep-2024.
[15] https://www.midjourney.com/ as seen on 3-Sep-2024.
[16] Ross, A., & Willson, V. L. (2018). Basic and advanced statistical tests: Writing results sections and creating tables and figures. Springer.
[17] https://www.dorsetindia.com/products/architectural-hardware/door-handles as seen on 3-Sep-2024.
[18] Bisht, D. S. & Jasmatiya, N. K. (2024). An investigation of key descriptors and factors for design and marketing of anatomical handles. International Journal of Creative Research Thoughts (IJCRT), 12(8), f239-f249. http://doi.one/10.1729/Journal.41225.