

What Have You Learned?

An Experimental Approach in Teaching Human Factors in Design to Undergraduate ID Students

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https://doi.org/10.21606/drs_lxd2021.11.223

This case study presents an in-class exercise as a way to learn about the course learning outcomes for a Human Factors in Design course carried out with undergraduate level industrial design students in the 2020-2021 academic year. The paper introduces the course content, comprised of the theoretical knowledge-sharing part, sample assignments and in-class exercises to define the context of the study. Watching the same short movie at the beginning and the end of the learning period, students responded to open-ended questions that encouraged them to think about how their perception had changed towards the content of the movie and to reflect on their take-aways from the course. Thematic analysis of the student responses helped identify the shared patterns in which students had developed an understanding of the human factors in design. A survey in the form of an in-class exercise also aimed to help students promptly be aware of the course outcomes to sustain their practices for upcoming design challenges.

Keywords: human factors in design; industrial design education; learning outcomes

Introduction

Human factors and ergonomics (HF/E) practices can be traced back to when humans started shaping materials like stones, bones and wood into simple artefacts that were useful in daily life (Elbert, Kroemer & Hoffman, 2018). As technology developed through the centuries, the HF/E discipline has incorporated studies of muscle-operated human and machine systems, and later on, communicative and cognitive conditions through the inclusion of computers into objects of use starting in the early 1980s (Interaction Design Foundation, n.d.). Recent advancements in mobile technologies have enabled human-computer interaction to be multi-faceted, hence increasingly complex. As Norman (2016) states, as a discipline originating from crafts, design must borrow perspectives from other disciplines, including HF/E, to reduce the intricacies of the interfaces that draw humans and technology away from each other. To bridge this gap, the Human Factors in Design course was structured to empower students to inquire about a variety of human conditions across changing situations, to prepare them for the unique challenges in design and to prevent the common mistake (Lee, Wickens, Liu, Boyle & Linda, 2017) of designing with intuition and making assumptions for the people they are designing for.

Information on the Context

Several lectures prepared the basis of HF/E, supported by in-class exercises and assignments that aimed to equip students to make assessments on human factors in design in a variety of circumstances. In this section, various course materials are summarized to give a brief idea of the structure of the course.

A Reflection Study as an Experimental Approach in the Human Factors in Design Course

At the beginning of the course, a brief history of the HF/E field and its purposes were introduced. After the introduction, students were shown a short movie based on the India Report by Charles and Ray Eames (Figure 1).



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Several aspects highlighted in the report were effective for the selection of this specific movie (1958/1997):

- The lota has a simple function: a liquid container;
- It is an object that can be used in daily life;
- It is a timeless product that has been designed by many people over an extended timeframe. It is possible to observe its development by investigating the variety of lota types;
- The authors had chosen the lota as an example that highlights an approach that may enrich design education in India.

In an open discussion, students were challenged to identify the human factors that affect the design of lotas before gaining any theoretical or practical knowledge about the research areas of the HF/E field. The students' answers are shown in Figure 2.



Figure 1. Screenshots from the movie: Variety of lota forms and usage in differing situations (Ahmedabad National Institute of Design, 1970/2018).



Figure 2. Human factors in the design of lotas that were identified in an open discussion with the students.

Course Content

The systemic approach has been the core of HF/E in the engineering of intricate relationships established between humans and machines (Sanders & McCormick, 1993). Today, systemic thinking has been adopted by designers addressing the complex issues, by changing one's perspective from individual objects to the relationship of its elements that work together as a system (Sevaldson, 2013). Embracing such an approach has required the introduction of the common features of systems, such as the 'hierarchy, environment, functions and interacting components' (Sanders et al., 1993, pp. 16-18), and of in-class exercises drawing the connections between the system elements. Visualizing such relationships and analyzing the human and product systems to 'see behind the products' was challenging for students coming from the design studio practice, where the design process is mainly focused on visualizing the physical appearance and material

properties of the products by sketching and prototyping. During these exercises, multiple feedback and iteration required for the formation of system diagrams as accurate as possible (Figure 3).

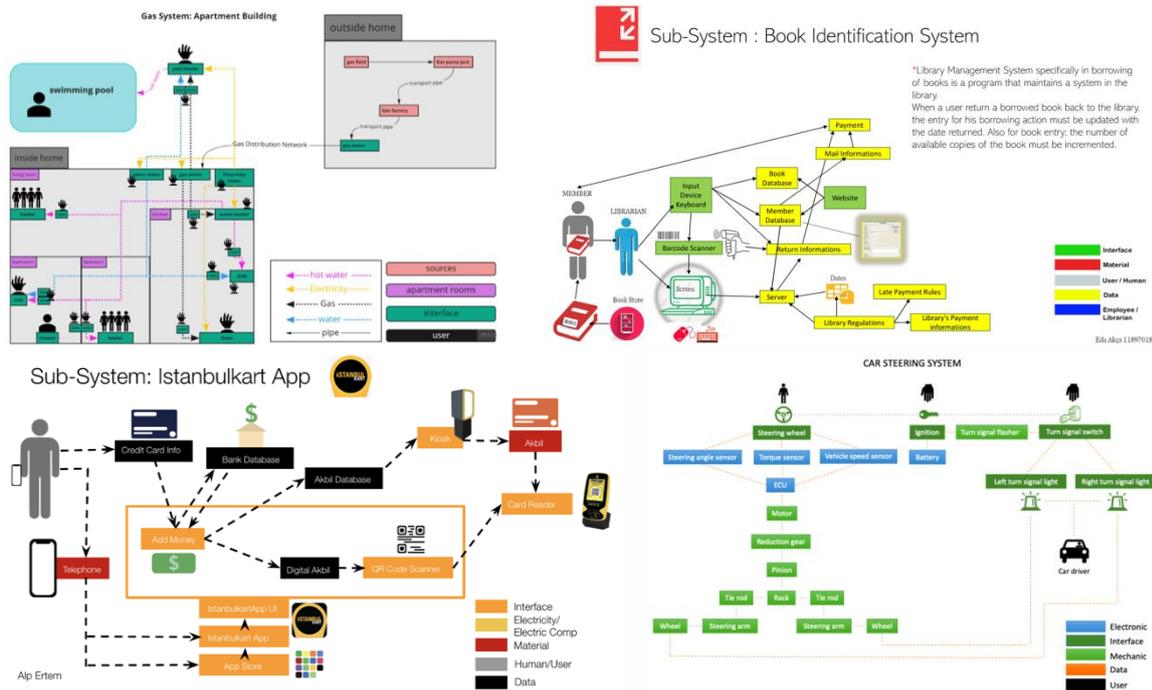


Figure 3. Examples of student work on visualizing systems. Visualizations by Abdullah Al Halabi, Eda Akça, Alp Ertem, Sümeyra Bay.

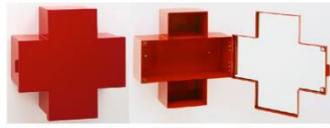
The systemic approach continued similarly towards the human body and its functions, exploring the physical abilities and limitations by a series of lectures on physiology, biomechanics and anthropometrics. Building upon the theory, an example exercise of a task-based posture and movement analysis in the kitchen workspace was adapted from Rapid Entire Body Assessment (REBA) (Hignett & McAtamney, 2000) to identify any improvement areas to reduce pain and increase comfort (Figure 4).

<p>Task Definition</p> <p>Task 2: Observing some postures and issues while cooking process and understanding to participants' experiences</p>	<p>Measurements</p>	<p>Posture Analysis</p> <p>Moment that starting to cooking</p>	<p>Posture Analysis</p> <p>Moment that close to finishing cooking</p>	<p>Task Definition</p> <p>Task 1: The testing participant to wash the pot and the cooking range. Capture and enable the participants' body posture. Ask the participants about their experiences. Did they have any pain or discomfort through?</p>	<p>Measurements</p>	<p>Posture Analysis</p>	<p>Posture Analysis</p>
<p>Participant Info</p> <p>Height of participant: 185cm Elbow height: 110cm</p>	<p>Kitchen Furniture Measurements</p> <p>Pot height: 12cm Pot center distance from the body: 30cm</p>	<p>Participant Experience</p> <p>Participants' complaints are elbow pain and neck pain. He also noticed that as some gaps for those points getting much more painful and those gaps blocking his to cooking.</p>	<p>Your comments</p> <p>The cooking hood location and stove height is getting things harder while cooking. The face is intersects to cooking hood so that body automatically getting second picture pose and it cause some load and painful posture while cooking. Stove height will be much more higher than as it is because of same reasons between elbow and cooking hood.</p>	<p>Participant Info</p> <p>Jekek Age: 23 Body Height : 173cm Elbow Height : 102 cm Weight : 59 kg</p>	<p>Kitchen Furniture Measurements</p> <p>Stove depth : 18 cm Stove top height: 87 cm Faucet distance : 36 cm</p>	<p>Participant Experience</p> <p>pain in the wrists neck pain from bending over mild back pain</p>	<p>Individual comments</p> <p>The upper cupboard had to be best as it composed in the participant height. Because the pot was large, she had difficulty moving inside the sink. Although that the sink was not compatible with the size of the participant because it was inside the upper cabinet basket.</p>

Figure 4. Examples of student work on the kitchen ergonomics assessment. Works by Eliz Ezer, Öykü Özdemir.

Exploring the human body's abilities and limitations proceeded with the studies on how the human brain works on tasks such as communication, memorization, and decision-making. Figure 5 shows an example assignment identifying the fundamental principles of interaction, such as 'affordances, signifiers, feedback and mapping' (Norman, 2013, pp 10-25), as communicative aspects that help humans comprehend how a product works without any verbal instructions.

**MEDICINE
 CABINET**
 thomas eriksson
 1992



Affordances: The front part of the product had a handle detail which gives us the idea to use it as a lid and affords us to pull and opened it.

Signifiers: We can understand that this is a cabinet but the shape and form of the cabinet is a signifier for us to put our medical stuff inside. It signifies that this is a product which is especially for medical stuff and pills.

Feedback: There is a magnetic detail between the body part and the lid. This detail keeps the lid closed. The sound of the two magnets sticking together while closing the lid gives us a feedback that the lid is completely closed.

40 Echo Dot Smart Speaker
 2014
 Amazon



Affordances: Speaker's buttons afford that we make the volume up or down, disable the microphone in the speaker or wake voice assistance, dismiss voice assistance.

Feedback: If we push the - button we will hear lower voice or if we push the + button we will hear higher voice. If we push microphone off button we will disable the microphone in the speaker. And if we push action button we will wake, hear voice assistance or dismiss voice assistance. And light is blue but if we push microphone off button light will be red.

Signifiers: There are some symbols on the buttons to show the button's function. For example, button which has + symbol on it is explaining that this button is for making the volume up and - symbol is for making the volume down.

Mapping: The button which has + symbol on it is above because it makes the volume up and - button is below because it makes the volume down. And if light is red we can understand that microphone is off.

Figure 5. Examples of student work identifying the fundamental principles of interaction with various products. Works by Gonca Öztürk, Miray Yılmaz.

Bringing the entire knowledge and experience gained through the lectures, assignments and in-class exercises together, the teams investigated the products and services with a series of inquiries involving the users. By planning and facilitating usability testing sessions, inviting participants and learning about the ethics of handling sensitive information, students experienced working with HF/E data to define improvement areas and propose adjustments on the selected products and services.

A Final Assignment of Reflecting on the Course Learning Outcomes

At the end of the 14-week course period, the students watched the lota movie for the second time. The following open-ended questions prompted students to reflect on their learnings from the course:

1. How did your thoughts and perception change regarding the factors described in the lota movie after watching it for a second time?
2. How would you describe the process of HF/E based on this movie?

Results

Answers from 35 students were collected in a short paragraph format and later used for a thematic analysis to obtain an understanding of the changing perspectives on the movie content and the course learning outcomes.

Regarding changing thoughts and perceptions toward the factors described in the lota movie, the responses clustered around themes such as 'paying more attention to the process behind the scenes, increased focus on humans, attention to usability and observation of different usage scenarios' (Table1).

Table 1. Themes generated on changing thoughts and perception.

Theme	ID	Student Responses
Development of a sense of appreciation for the design process behind the scenes.	0220	In products such as pottery, we generally focus on its appearance without considering human factors. It was like in my thoughts. If I was going to buy such a product, it would not be important to pay attention the usage details or human effects before this video. Previously colors or design details were more effectively for me. When we get into these important details, we see the importance of design according to human factors before appearance.
	0520	Before class, I was looking at products just as products. This video in particular opened my horizons. I was excited to see the details behind a product that looks simple.
	0720	In the video, what was thought while designing the product was explained in detail. And maybe when we first looked, I saw how much thought was taken even for an object that we can only see Lota. The gender of the person using that object, the way of carrying, the way of holding, the way of use is all made by considering the human factors.
	1120	After I learned about the ergonomics and details of interactions between human and product, I thought I now know how to look at a product. Since the users are human and in daily life users usually don't think about the design and the process of the product,

		we as designers need to know and study on these important points. This is like a behind curtain management of necessary basis.
	1520	One detail can make a big difference. In the beginning of this class, I couldn't understand how everything is related to each other while creating the Lota. But right now, I learned from ability to carry it on the head (balance), to the points that is carved for us to carry it easily is all related to each other and it is what gives a product (lota) its identity .
	1720	Now I can understand that the behind scene of designing something with solving errors on it and produce some solutions about those design problems with the help of methodologies
	2420	At the first time I thought watching the documentary of the "Lota" I thought that the Lota was made with instincts , the fact it was ergonomically suited for carrying it is an important factor but I thought it was probably a coincidence , but now watching it for the second time I understand it was well thought, the factors such as balancing, cleaning easily, holding...
	2520	Lota is a product that reflects the design phase very well . Not only is it a good design in its own right, it is also a good design in terms of the vessel design process that has developed so far.
	2920	Now after everything we talked about, I can understand the process and the ergonomics behind.
	3220	When I watched it for the first time, I did not know much about the design process and I did not realize that the design had to be made so comprehensive . I think this video is of great importance in understanding that the design process is not just about drawing .
Shift in perspective from product to the people who interact with the product	0420	I learned that the design gets affected by many things like the age of the user their body ergonomics the product shape, weight, center, etc. The culture of the user might affect the product in those terms as well. Because of each region the people there might have a different ergonomics then other region (in general) so shape and size will get changed in order of that like we can see here is the same products but with different shape in different culture.
	0520	It impressed me that a product was compatible with the human body in so many different ways. It was an example of the harmony of objects with humans . I realized that when designing a product, the most important thing is to examine its relationship with people . Because actually, every product is for a human need and interest .
	0620	I realize I didn't even need to watch the whole video to understand what kind of relation it has between human and design . Because we looked at a lot of designs throughout the term so I kind of knew what a simple design needed to be able to interact with humans accurately . As we can see everything from the mind and the body of humankind is put in consideration when designing even a simple Lota.
	0720	I saw the importance of the topics we saw in our lesson. Because even if it was not really designed under the titles of our lesson, people thought of all of these issues while designing Lota in the past and developed it according to the human factor.
	0820	Lota is a vessel of everyday use. In the beginning of the semester, I thought, it was designed to consider the factors like storage size, size of the opening, and how they carry the product. Now, my perspective is changed thanks to outcomes of the human factor course. For example; it was designed with considering the factor like gender differences of anthropometric measurements, ... the walking and static pose .
	1420	When designing a product, making a product that meets human needs is always very important for that product.
	1620	I now know how to differentiate the factors described on the Lota. Human factors in design is everything that is related to the human , it might be measurements or it might be how we act and how we behave towards objects . In this process we analyze the relationship of humans with the product . We analyze the factors of the human . We

		design systems that include humans in them rather than products with no relation to humans.
	1720	...the shape of the Lota designed to be coherent to head in terms of physical abilities, affordance and also usability.
	1820	When I design something, I should consider what my users need according to their ergonomics how can I make it usable by all of them with no problem. They might be old and face problems with the new things or they might be young and it (might) be easy for them to use new things.
	1920	Thoughts gaining dimension from thinking about how the product shaped, worked, carried and what is it made of. I have come to the conclusion that what is important is the user.
	2020	Beginning of the class I knew the relation between design and human but I was not familiar with deep aspects of it. Decision of the size, type, form, ability, cause and relation with its users (human factors) is what makes the product usable and successful while thinking every aspect of it.
	2120	User's experience very important ... to understand relation of design and user.
	2220	So, at the moment I can understand the relations between human and products.
	2520	The vessel is based on many features that appeal to people when it becomes a Lota.
	2620	Like in the video about Lota they were looking and analyzing the user. We are product designers so our job is with humans and their usages.
	2720	The comfort of the usage increases because the product form is compatible with the human body.
	3020	Compared to the first time I watched it, I can understand more easily the human product relationship and in what ways it is harmonized with each other.
	3320	when we watched it again, I began to focus not only on the whole of the events, but also on the details. We now think according to the harmony of objects with humans, their relation to humans.
	3420	I understood the influence of people on the production of products better.
Increased attention to the issues of usability that are not visible at first sight.	1220	I learned that we need to consider everything when we are designing something, from the usage to the design itself.
	1820	This year I learned that every part of the design serves much more questions and purposes. For that I realized how all these questions and objectives work, how enormous details they actually have. Even if seems like a simple pot or lota it actually refers everything that people use in their daily life.
	2220	After watching the video for twice I realize that, I was looking too much general to products in the beginning of this course but now I understand products qualities for usage more detailed.
	2920	The balance, the sound when it is empty, the size, the dynamics, the optimum amount of liquid to be carried or stored. All these factors are so important for design because when you jumped into the end and you didn't think of all the processes you can't get any useful or satisfying product.
	3020	In addition to the physical fit, I can also see what kind of design details have been applied in terms of efficient use of the product during and after use.
	3120	Sound and color of Lota was only characteristic feature when I first watch Lota. I focused more on the process of using and feeling of the product after I take Human Factors class.
	3220	When designing a product, it is necessary to think about every situation and shape its form accordingly and at the same time not to miss what it is used for.
Observing the	0220	They think about how it can be carried in more comfortable way or which angle of carrying on the arm does not disturb people.
	0320	

human and product relationships in varying situations.		...there are many ways to carry the jar , such as carrying it on the head or on the waist or tying it to a stick to carry a larger quantity. I recommend making a handle with wheels for large sizes to facilitate transportation from one place to another .
	0420	The cooking pot in United Kingdom is different than the cooking pot in India. This might be because of the available material around them or because of the different ways of cooking ...
	0520	Many details such as our hands not being burnt when transporting hot water have been considered for human-product relationship. Lota can also be carried on our head, in the bend of our hips, by cart or with a long wooden stick by determining the center of gravity.
	0920	Also, in the design process, a designer must be thinking through a lot of objectives . If we give an example from the lota, the only perspective should not only be the carrying of the lota; the cleaning or the carriage of more than one lota is also should be a very important consideration point.
	2320	I realized that this ancient vessel 'Lota' is still usable in our everyday life. Also, there are factors inside the factors such as usage and storage , so we should think and design our products according these things.
	2520	The center of balance is a very well-adjusted design. When it is empty and full , it can be easily transported in either way. It does not disturb the user in both cases when we carry it on the head and support our arms .
	2620	Lota is something people carry with their hand so it has to be a balanced product, its inner contour has to be big to clean easy and feel comfortable, posture of the usage is important so that they made Lota for gender of hands.
	2820	When designing lota, attention should be paid not only to use but also to situations such as moving and cleaning .
	3020	
	3220	I understand how important ... the details even when the product is not in use or even standing still. Since they contain liquid substances, the balance is also of great importance because the liquid must not be spilled while taking liquid or carrying it on their heads . the upper part of the lota is designed to be narrower so that the liquid does not spill, but if we consider it in terms of cleaning, this process could be a bit difficult , and I think it is one of the most important situations that they make and produce the design in detail and useful for these two situations .

On the process of HF/E, the responses were collected under themes such as 'generating ideas, process as a continuous cycle of trial and error, and cumulative development' (Table2).

Table 2. Themes generated about the process of HF/E.

Theme	ID	Student Responses
HF/E practices provide methods to generate design ideas.	0120	My perception was developed more because I recognized again that "product is more than a product" and it is always developable because we can always define some problems or needs on a product then we developed or change something on the product by thinking some factors.
	0420	When I design something I should consider what my users need according to their ergonomics how can I make it usable by all of them with no problem and their culture because they might be old and face problems with the new things or they might be young and it be easy for them to make new things.
	0720	I started thinking this way as I approached an object . Because things such as function, ease of function, comfort, usefulness are more important in the design process. I started making comments as if this was a little taller here, not for your average height, I have also been grabbing the objects around me .
	1220	

		The design itself is an important part because a product can be designed many ways but the most ergonomic way of designing is better.
	1320	When I watch it the Lota video again now, I can say that human factors such as ergonomic, aesthetic, anthropometric and psychological affected the product and environment and system of the product produced at that time.
	1720	I learned many things that can help me to understanding design world and designing proper systems or products according to Human Factors and Ergonomics principles. What I achieve is that human factors is to reduce human error, increase productivity, and enhance safety and comfort with a specific focus on the interaction between the human and the thing of interest.
	2120	User's feedback can be more efficient to improve a design, while they use it, they understand what is missing, what are their needs for more useful usage.
	2620	In Human Factors course I learned that first we discover the problem then we define it and develop our product.
	2820	
	3520	In short, an attitude that will evaluate and solve our problems should be formed I started thinking more detailed and start seeing the needs or thinking how we might change, develop it.
HF/E	0120	I recognized that these factors always effect to improve and design an object.
develop	0920	The ergonomics, feeling or measurements, all of them are based on humans' possibilities. But all of these factors are not always being considered at the same time. Designing is a generally a process that is evolving trough the previous mistakes.
ment is a		
continuo	1320	increased my awareness of the subject. When we looked at our course content and especially the exercises we did, I realized that although it looks roughly like the material system we live in and the period after the Industrial Revolution but in fact, its foundations are much older times.
us cycle		
of trial	1820	That's not a first shape of the Lota that we watched, it's improved version of I think like how it improved in our daily life product like carafe. A product needs to be revised many times to be used but the user only sees the latest versions of the product.
and	2420	Also, the process of human factor in design always existed, even in the oldest products. Humans always tried to make daily products suitable for themselves.
error.	2720	The product reaches to perfection, not by a design of one person, but moving it forward with the involvement of many people over many years.
	3020	Apart from these, I can see that design is not something that starts and ends, and as the product is used by humanity, the design process continues, whether intentionally or unintentionally.
	3520	I think the process of human factors in design is a long and experimental process.
Ideas	2420	The process of human factors in designs is something cumulative. As the narrator of Lota said the Lota was changed man after man and every change add something new to the Lota.
develope		
d by the	2520	Since ancient times, vessel has always been a product that has been designed and considered. In the course of time, the details considered necessary were kept and unnecessary details were removed, and it became the current Lota. Problems with a bowl were identified and each time they added new information to it.
HF/E		
assessme	3520	First design is providing all preconceived ideas and after it starts changing with considering the sizes, the center of the gravity, motions, static pose, cleaning, how it is using, material and the cost. It happens step by step with trying and thinking about these. Things that we use is developing each day by adding or removing.
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Discussion

The responses to the first question were helpful in identifying the areas in which the students developed their perspective on the course content. In contrast with the starting phase of the course, students were able to

articulate their ideas on human factors in design instead of verbalizing mere keywords. From the answers, it is possible to observe the development of a sense of appreciation for the extensive design process and the numerous details that form a simple product like a lota. The responses demonstrated a shift in student perspectives from the physical aspects of the product to the human beings who interact with the products. A group of students specifically mentioned paying more attention to issues of usability that were not visible at first sight. Elaborating on the usability with a more developed perspective, students explored the usage scenarios in a variety of human conditions under different circumstances.

Responses to the second question helped to observe students' understanding of the process of human factors in design. The HF/E methods provide a variety of ideas for designers. However, these ideas aren't necessarily implemented at once; it is rather a process that carried out as a continuous cycle through trial and error, implemented as gradual changes of adding or removing.

In this learning period, the lota movie became a tool to stimulate the memories of the students on their learnings from the course. A comprehensive documentation on the design development of lotas aided the discussion without the interruption of trending technological developments such as mobile user experiences that take place on touch-operated screens. By answering the open-ended questions, students reflected on their thoughts about the movie content within the context of the HF/E practices. The student responses demonstrated that the movie was helpful in emphasizing the iterative approach of human factors in design, still valid today (Lee et al., 2017; Norman & Meyer, 2019). Additionally, it was possible to capture student perspectives on the issues of usability.

The script of the movie mainly included the physical factors that affect humans who interact with lotas, which invited students to elaborate especially on the physical ergonomics topics in their comments. For future studies, additional materials should be used to spark discussion on cognitive factors to explore how the human brain works and affects the design of products and systems. It is possible to expand this exercise by including more audiovisual materials to reflect on more topics in the HF/E field.

Conclusion

Norman (2016) manifests the need for an improved approach on design education beyond craftsmanship to establish a better connection between the human and advancing technology. At this point, despite being an object of craft, the lota in the movie provides suitable discussion grounds for approaches to HF/E. In the India Report, instead of highlighting how and from which materials the lota is made and elaborating on its appearance, Charles and Ray Eames inquired deeper on "who" uses the lota and how they use it (1958/1997). One of the main aims of the course was to design the learning experience of students to help them develop their own sense of approach towards unique challenges in design. Theoretical knowledge with various exercises and assignments suggested the creation of learning environments where students explore a variety of factors in changing situations. Revisiting the movie for a second time at the end of the learning period, student responses demonstrated a shift in their perception regarding the human condition as well as a greater awareness of the comprehensiveness of the design process behind the surface.

The intention of this exercise was not to measure the knowledge level of students with numeric values, as written exams do. As HF/E practices carried out as a continue cycle, the aim was to help students promptly be aware of their take-aways from this course, thereby encouraging them to sustain their practice for upcoming design challenges and to continue building on their experiences. For the lecturer, to receive reflections from the students with a more developed understanding on human factors in design, has been a rewarding experience.

Acknowledgements

I would like to thank the students of the Human Factors in Design course at İstanbul Bilgi University, Department of Industrial Design in the 2020-2021 academic year, fall term, for providing the valuable thoughts and comments that formed the basis of this paper.

I would like to express my deep gratitude to Prof. Dr. Özlem Er, for her guidance and valuable support through my teaching experience and her constructive recommendations on this study. Special thanks should be given to Dr. Berrak Karaca Şalgamcıoğlu for her encouragement on teaching human factors in design course and her initial guidance on building the course contents.

References

Eames, C. & Eames, R. (1997), The India report. (Original work published 1958). Retrieved from http://nhttps://doi.org/10.21606/drs_lxd2021.edu/Userfiles/Eames___India_Report.pdf [accessed on

March 2021]

- Elbert, K. E. K., Kroemer, H. B., & Hoffman, A. D. K. (2018). *Ergonomics: How to design for ease and efficiency* (3rd edition). Academic Press, an imprint of Elsevier.
- Hignett, S., & McAtamney, L. (2000). Rapid entire body assessment (REBA). *Applied Ergonomics*, 31(2), 201–205. [https://doi.org/10.1016/S0003-6870\(99\)00039-3](https://doi.org/10.1016/S0003-6870(99)00039-3)
- Interaction Design Foundation. (n.d.). Human Factors. In *The glossary of human computer interaction*. Retrieved from <https://www.interaction-design.org/literature/book/the-glossary-of-human-computer-interaction/human-factors> [accessed on March 2021]
- Lee, J. & Wickens, C. & Liu, Y. & Boyle, L. (2017). *Designing for people: An introduction to human factors engineering* (3rd edition). Create Space.
- National Institute of Design Ahmedabad CMR. (Jul 12, 2018). *Lota* (Original work published 1970). [Video]. YouTube. https://www.youtube.com/watch?v=BMC5gDv_Yos
- Norman, D. A. (2013). *The design of everyday things: Revised and expanded edition*. Basic Books.
- Norman, D. A. (2016). When you come to a fork in the road, take it: The future of design. *She Ji: The Journal of Design, Economics and Innovation*, 2(4), 343-348. <https://doi.org/10.1016/j.sheji.2017.07.003>
- Norman, D. & Meyer, M. W. (2019). Changing design education for the 21st century. *She Ji: The Journal of Design, Economics, and Innovation*. Volume 6, Issue 1, Spring 2020, Pages 13-49. <https://doi.org/10.1016/j.sheji.2019.12.002>
- Sanders, M. S., & McCormick, E. J. (1993). *Human factors in engineering and design* (7th edition). McGraw-Hill.
- Sevaldson, B. (2013). Systems oriented design: The emergence and development of a designerly approach to address complexity. *DRS//CUMULUS 2013 2nd International Conference for Design Education Researchers*.

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