Development and Promotion of Educational Materials on Human-Centered Design

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Abstract—**Human-Centered Design (HCD) is the design principle that focuses on the users of services, systems, or products. The idea of HCD was proposed more than two decades ago, and it has been widely adopted in the Information Technology (IT) and design industries. However, entry-level educational materials are needed to increase the popularity of the concepts among consumers and students who study engineering and industrial design. The Human-Centered Design organization (HCD-Net) is a specific non-profit organization that promotes the concept of HCD in the Japanese industry. It has a Working Group (WG) whose members have been tasked to develop the required entry-level educational materials on HCD and to promote them to the industry. This paper describes some of its activities. As per the HCD cycle itself, we distinguish between the development and the promotion of the materials. The results of their efforts have been of great value to the people who have to teach the HCD concepts to newcomers.**

Keywords–Human-centered design; Educational materials; HCD cycle.

I. Introduction

Human-Centered Design (HCD) is the concept of a design process where the designers design their services, systems, or products focusing on the users of them. That is, HCD is considered as the user-oriented design process. The concept of HCD was proposed more than two decades ago, and it was standardized by the International Organization for Standard (ISO) as ISO 13407 in 1999. Also, it was integrated into ISO 9241 in 2010 (ISO 9241-210:2010), adding the concept of User eXperience (UX). Subsequently, it has been updated to ISO 9241-210:2019 in 2019 [1].

In Japan, a non-profit organization, the Human-Centered Design Organization (HCD-Net), was established in 2004 [2]. HCD-Net aims to assemble knowledge on HCD and to promote methods and skills regarding HCD. Due to their long-term efforts, the concept of HCD has been widely adopted among experienced engineers, especially in Information Technology (IT) and design industries. However, it is still not popular among consumers. Surprisingly, and unfortunately, even students who study engineering and industrial design are not so familiar with the HCD concepts [3]. Therefore, entry-level educational materials are needed for training newcomers to perform in accordance with HCD processes.

Although there are many training services, educational materials, books, and seminars for the higher-level training on HCD activities, unfortunately, we have few items that can be used as the educational material for introducing basic knowledge of HCD. Hence, entry-level educational materials on HCD are needed.

Several Working Groups (WGs) were established in HCD-Net to fill the gap between entry-level and high-level education due mainly to the lack of educational materials. The members of these WGs have been actively working to achieve their goals. "The fostering teachers WG" was established in June 2016, and it meets monthly for face-to-face discussions. In addition to the meetings, several events have been held by the WG and the work has been actively progressing [4]–[7].

The rest of the paper is structured as follows. In Section 2, we present the basic idea of the HCD process. In Section 3, literature reviews are described. In Section 4, the WG's strategies are illustrated. Then, in Section 5, we discuss how the HCD process worked in the WG's activities and the value of the educational materials delivered as their work. Finally, we conclude in Section 6.

II. The HCD Process

Before explaining the WG's activity further, we describe the basic idea of the HCD process to better understand the character of the WG's work.

The HCD standard is a process standard, i.e., the standard defines several processes to realize an efficient design from the viewpoint of a user. The general phases of the HCD process can be explained with the following steps: (quoted from [8]).

1) *Specify context of use: Identify who the primary users of the product, why they will use the product, what are their requirements and under what environment they will use it.*

2) *Specify Requirements: Once the context is specified, it is the time to identify the granular requirements of the product. This is an important process which can further facilitate the designers to create storyboards, and set important goals to make the product successful.*

3) *Create Design solutions and development: Based on product goals and requirements, start an iterative process of product design and development.*

4) *Evaluate Product: Product designers do usability testing to get users' feedback of the product. Product evaluation is a crucial step in product development which gives critical feedback of the product. The important point is that this cyclical process must be repeated several times to satisfy the service level of the users' requirements.*

WG members are in charge of creating the entry-level materials and of training the trainers who can teach the basic concepts of HCD by using their materials. The fact that their activities themselves were based on the concept of HCD should
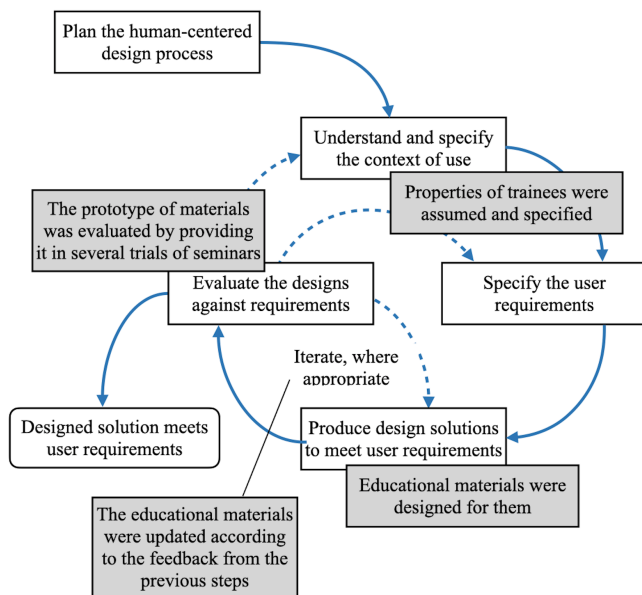
Figure 1. The WG's activities along with the concept of HCD defined in the ISO 9241-210.

be noted; that is, the designing process of their products was as follows: 1. Properties of trainees were assumed and specified. 2. Educational materials were designed for them. 3. The prototype of materials was evaluated by providing it in several trials of seminars. 4. After that, the educational materials were updated according to the feedback from the previous steps. Figure 1 illustrates the processes defined by ISO 9241-210 and the cases adopted to WG's activities in each step, respectively.

III.   LITERATURE REVIEW

As the concept of HCD is more widely recognized, HCD education is gathering more and more interest from engineers in various fields. Instructors in this field are paying special attention to how to teach UX concepts. Some case studies in universities and professional training colleges have been reported. However, it still remains unclear how to help newcomers understand HCD in the real business field.

Ito *et al.* [9] reported their implementation of the e-learning course on the basics of HCD. They were working for a computer-electronics manufacturer, and their e-learning course was intended to prevent miscommunication regarding user interfaces among the employees. It was a good example of HCD education conducted in the enterprise.

Gonzalez *et al.* [10] surveyed 140 students who were members of the Human Factors and Ergonomics Society (HFES) and analyzed 40 UX job postings. The results show that there is a discrepancy between the skills the UX industry expects students to have, and the skills HFES promotes for a career in UX. They recommended a focus on increasing HFES's relevance to students interested in future UX careers. Vorvoreanu *et al.* [11] also reported on the UX education for undergraduate students at university.

The concept of "design thinking" is a similar idea to UX design. Wrigley *et al.* [12] focused on surveying the design thinking education provided as Massive Open Online Courses (MOOCs). MOOCs are open to the public and most can be participated in for free via the Internet. Therefore, anyone who wants to learn about design thinking can acquire the knowledge by accessing the courses presented on their web-sites.

Dirin and Nieminen [13] studied the relevance of User-Centered Design (UCD) education to a mobile application development course implemented in a university. They analyzed the feedback from students and concluded that UCD education had a significant role in the development and improvement of students' capabilities on consulting and user study research.

We can find many other cases where HCD or UCD processes were introduced to education programs in various fields; Adam *et al.* [14], Organ *et al.* [15], and Carter *et al.* [16] reported cases in health and medical education, Harvey *et al.* [17] reported a case in fashion education, Wilson *et al.* [18] discussed the possibility of applying the UCD approach to the training environment for aircraft maintenance personnel, and Bowie and Cassim [19] argued for the HCD methodology in contemporary communication design education. These papers reveal the presence of a potential need for HCD education in various domains.

Additionally, there are some studies on designing or evaluating a curriculum by incorporating HCD processes similar to our approach, in creating their educational materials. Altay [20] pointed out that there is a similarity between the learner-centered approach in education and the user-centered approach in design disciplines. Altay illustrates this by adopting a user-centered approach within the human factors course as one of the learner-centered instructional methods. Reich-Stiebert *et al.* [21] explored robot design education by means of the HCD approach. They investigated students' preferences regarding the design of educational robots and evaluated the course according to the results. Chen *et al.* [22] reported on the results of evaluating the curriculum using a method of creating student personas in the field of resource engineering education.

IV.   THE WG'S STRATEGIES

The starting point for the WG's activities was the textbook published as the first of the HCD book series. Based on the contents of the book, the WG considered two strategies; one was to develop presentation slides and guidebooks as the educational materials, and another was to foster trainers who could provide seminars to newcomers who were not familiar with HCD.

Under these strategies, the WG created two prototypes of the educational materials for engineers and salespeople. Furthermore, some simulated seminars were conducted to acquire feedback and opinions to brush-up the materials.

A. Educational Materials for Engineers

The first target was newbie engineers who were not familiar with the concept of HCD. The WG published a beta-version of the presentation slides in June 2017, after several discussions by the WG members. After collecting some feedback, the materials were updated, and version 1.0 of the educational materials were published in May 2018.

The presentation materials have 42 slides, which are intended for conducting a seminar of approximately one-and-a-half hours. An overview of the contents is as follows:

1)   Case studies
2)   The concept of human-centered design
3)   Usability
4)   Introducing the HCD cycle

5) Appendix (good practices)

Figure 2 shows some examples of the educational materials. The upper left of the figure is the cover page, the upper right shows an example from the case studies, the lower left illustrates the HCD cycle, and the lower right is the cover of the appendix.

As it can be seen from the small icon at the corner of the cover page (see the upper left of Figure 2), the materials are published under the license of Creative Commons (CC BY-NC-SA 3.0). Therefore, everyone can share, redistribute, modify, and create deliverables based on this product, if they follow the conditions defined by the CC-license. This licensing strategy is especially helpful for future trainers, who the WG also wants to encourage because those educators are allowed to modify educational materials as they like.

Figure 2. Examples of the presentation slides for training engineers.

B. Educational Materials for Salespeople

After finishing the creation of the entry-level educational materials on HCD for engineers, the WG started a discussion on another version of the educational materials. The members of the WG considered that the people in the front office who had contact with their customers had to know the HCD concepts. Especially in the case of 'business to business (B2B),' such businesses require customers' understanding and cooperation. Hence, the WG decided on salespeople as the next target for education on the idea of HCD.

At the beginning of the preparation work, the WG invited some salespeople and producers who were using HCD processes and worked directly with their customers in their daily business activities. The WG members had several interviews with them to get to know their mental thought processes, how they worked with their customers, etc. Also, they invited salespeople who did not know the HCD to attend an entry-level HCD lecture, so that the discussions could be fruitful for both sides.

Although the base materials were those for engineers, minor modifications were made to the original ones. There were two significant changes; one is that the thoughts of the customer-orientation investigation were introduced instead of the case studies. The other was that the discussion on the positioning of the HCD was added before the conclusions. The

latter part also mentions the User eXperiences (UX), because the UX is also a key topic for discussing HCD-related issues with customers. The overview of the contents for salespeople is as follows:

1) Considering the view of the customer-oriented
2) The concept of the human-centered design
3) Usability
4) Introducing the HCD cycle
5) Positioning of the HCD
6) Appendix (good practices)

The education materials of the HCD for salespeople were released in May 2019 (version 1.0).

C. Guidebooks

In addition to providing the presentation slides, the WG also supplies a guidebook on how to conduct efficient training on HCD. Generally, it is not easy to run seminars along with the presentation materials when they were created by other individuals. Therefore, guidebooks to run training courses for trainers using two versions (for engineers and salespeople) of educational materials are also provided.
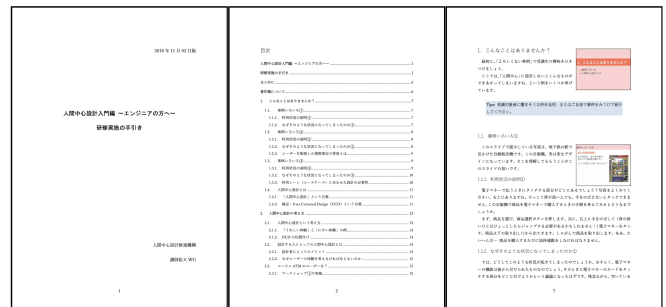

Figure 3. Examples of the guidebook for training engineers.

Figure 3 shows some examples of the guidebook for the educational materials for training engineers. The left of the figure is the cover page, the middle shows the table-of-contents, and the right shows one of the instructional pages.

As it can be seen on the right in Figure 3, the instructions are described for all presentation slides. The guidebook helps novice trainers by giving some additional information on how to teach the topics, etc. All the educational materials (presentation slides) and complementary guidebooks are uploaded to the server hosted by HCD-Net. These can be downloaded from [23] (for engineers) and from [24] (for salespeople).

D. Simulated Seminars (Trial Events)

To evaluate the prototype of the educational materials and lectures, the WG held five simulated seminars. Table I shows a list of trial events officially announced by HCD-Net.

TABLE I. THE LIST OF TRIAL SEMINARS.

ID	Target	Version	Date	Participants
1	Engineer	alpha	Mar 4, 2017	18 pros and beginners
2	Engineer	beta	Aug 29, 2017	10 pros and beginners
3	Engineer	ver. 1.0	May 25, 2018	21 pros and beginners
4	Salesperson	beta	Jan 19, 2019	18 pros and beginners
5	Engineer & Salesperson	Modified	Dec 19, 2019	26 (mainly) beginners

The target of the first three seminars (ID 1, 2, 3) was the version for engineers. Lectures based on the alpha version, the beta version, and version 1.0 were examined in each trial, respectively. The next one (ID 4) was for salespeople. At that time, the beta version of lectures for salespeople was confirmed. We asked for HCD professionals to participate in those trials (from ID 1 to ID 4). Therefore, we could hear various opinions from not only beginners but also from professionals. Furthermore, the trial seminars were helpful for those professionals because most of them were in charge of human resource development, and they had motivation to take the contents of the entry-level workshops back to their companies.

V. DISCUSSIONS

As described in the previous section, the WG created the educational materials and the guidebooks in accordance with the HCD processes. In this section, the compliance with such methods, and the values of the WG's products are discussed.

A. How the HCD Process Worked in the WG's Activity

Looking back, in this section we consider how the four steps in the HCD cycle were applied to the WG's activities. We recall that the HCD cycle has four steps: specifying context of use, specifying requirements, creating design solutions and development, and evaluating products.

1) Specify Context of Use: As we described in the introduction of this paper, our study aimed to create entry-level educational materials and to encourage the instructors who present the training in their organizations. Considering the situations and experiences of each WG member [4][5], the WG decided on engineers as the first target group of trainees, and then salespeople as the second target group of trainees.

2) Specify Requirements: Because the educational materials are essentially designed to accompany the explanations of the textbook, the important part of the WG's work was to decide which components should be selected. Furthermore, the course time was considered very short. At the beginning of the WG's discussion, it made the assumption that the entry-level education on HCD would be conducted in one or two hours. Therefore, the members tried to not make the contents of the materials too complicated. Also, the members discussed what the participants of the lectures would consider important for their studies and their future careers. That is one of the essential points of the WG's activity in the view of the HCD concept.

3) Create Design Solutions and Development: The WG's process for making the materials was iterative, requiring at least two cycles.

The first cycle started with the prototype of the educational materials for engineers. The product was firstly published in its beta version. The WG then collected feedback and comments at the trial seminars (see Section 4.4). After that, the materials were published as version 1.0, and currently, it has been updated to version 1.1.

The second cycle was based on the first one. The prototype of materials for salespeople was started from the latest version of that for engineers, and then updated according to the WG's interviews and feedback from trial seminars. It was published as the beta version, and updated to version 1.0, as well.

4) Evaluate Product: Evaluation by the potential users is a very important process in the HCD cycle. In the WG's activities, the members also considered it the principal process. As described previously with the trial events run to evaluate the materials during the design phase, the WG remained focused on the evaluation process.

The WG's main work in 2019 was the evaluation, improvement, and investigation of which organizations were really utilizing their materials. Several new members, who were users of the materials, joined the WG in 2019. The educational materials and the guidebooks were updated according to the results of interviews conducted with them and feedback from questionnaires.

B. Value of the Educational Materials

The aim of the WG was to prepare entry-level educational materials and to foster instructors who can teach newcomers not yet familiar with the concept of HCD. Therefore, by providing the educational materials, it tried to fill the gap between newbies and experienced engineers, designers, and salespeople.

A review from Amazon's sales listing of the textbook states that: "It is not easy to understand only by reading. It will be worth reading if some lectures were provided using this book as its textbook." We had to agree with this comment. Hence, our decision to provide lectures on the entry-level HCD knowledge with these materials and guidebooks.

During the work conducted in 2019, the WG collected several opinions and impressions of the products from the new members. All of them mentioned that it was useful, but there was still some room for improvement. As the materials were provided under the CC-license, the users could modify the contents, so that it could become suitable for their own courses.

VI. CONCLUSIONS AND FUTURE WORK

The members of the human resource development WG, which was set up in HCD-Net to implement the entry-level educational materials on HCD and to foster lecturers who can train newcomers in each organization, have been working actively during recent years. This paper described their activities and provides an overview of their results. The most significant feature of their work was the fact that their outcomes, that is, the HCD educational materials themselves, were designed according to HCD processes.

The educational materials they created are intended for two different target groups; one for engineers and another for salespeople. Firstly, the training materials for engineers were designed. After that, based on the first prototype, the revised ones for salespeople were created. Guidebooks for conducting the training were also created to accompany the educational materials to make it easier for the lecturers to present these materials.

The WG's main activities in 2019 were conducting interviews with the users, delivering questionnaires to them, and improving the educational materials according to the feedback, as described in the last part of Section 4.1. However, more in-depth analysis of the feedback remains to be done as part of their future work.

Several evaluations were conducted as part of the HCD cycles. In particular, we carried out a series of simulated seminars and interviews with users of the prototype versions.

However, the lectures using these educational materials should be more widespread if we want to let the HCD concepts penetrate into all of the industries. More and more promotions will be needed, and they remain our future work. Furthermore, more evaluations to improve educational materials should be conducted. It will be an ongoing task as part of the WG's future activities.

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