INTERNATIONAL CONFERENCE ON ENGINEERING AND PRODUCT DESIGN EDUCATION
12-13 SEPTEMBER 2019, DEPARTMENT OF DESIGN, MANUFACTURING AND ENGINEERING MANAGEMENT, UNIVERSITY OF STRATHCLYDE, UNITED KINGDOM

A PILOT STUDY: A CASE STUDY OF DESIGN TEACHING APPLYING THE INTERNET CROWDSOURCING TECHNOLOGY FOR UNDERGRADUATE DESIGN STUDENTS

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ABSTRACT
Since the design education system was first established and spread to the public by Bauhaus in Weimar, during 1919, people began to realise the necessity and rationality of design education in various design domains. Currently, design has strongly combined with the new emerged internet technologies (i.e., crowdsourcing technology), and recent research results suggested that crowdsourcing design method (i.e., Crowdsourced Design Framework) provides innovations for design. Consequently, the teaching of crowdsourced design method for the undergraduate design students has become increasingly important. Unfortunately, at present, it was hardly found that this application in the current design course module. In this paper, the authors firstly investigated the application of crowdsourced design method (i.e., Crowdsourced Design Framework) for undergraduate industrial design students. This paper is structured by 5 sections. Section 1 gives a brief introduction of the development of design education, Internet crowdsourcing technology and the latest related research findings on it. Section 2, authors illustrate the Crowdsourcing-based Design Teaching Workflow (CBDTW). Section 3 shows a case study using the CBDTW for the 2nd year undergraduate industrial design students in Sichuan University. Students' design results are shown and discussed in section 4. This paper ends by section 5 as the conclusion, limitation and the future work. Students applied crowdsourcing technology to generate design concepts, evaluate designs and improve designs. Importantly, it is worth introducing the latest crowdsourced design research results to students, which potentially helps them understand how design research changes the way of design.

Keywords: Design education, crowdsourcing, crowdsourced design, crowdsourcing-based design teaching workflow (CBDTW), undergraduate education, internet supported design

1 INTRODUCTION

Since German Bauhaus brought its basic design courses and theories to the public in 1920s [1], design education has been combined and improved by the most fashioned and latest design research and practice results. In current higher education, within the engineering, product or creative design teaching model, researchers and academic staff never stopped to combine the traditional design process and the latest design research results in teaching [2][3][4]. Especially, with the boom in internet technology, new internet based design tools or methods (i.e., crowdsourced design [5]) take titanic positions in design process.

1.1 Crowdsourcing, Crowdsourced Design and cDesign Framework

In 2006, "crowdsourcing" was defined by Jeff Howe as "the act of a company or institution taking a function once performed by employees and outsourcing it to an undefined (and generally large) network of people in the form of an open call"[6]. This new type of "crowd" is made up by anonymous groups [7][6]. Crowdsourcing groups include online product communities [8][9][10], virtual communities of special interests [11], the general public [12][13], and employees who typically would not participate in the tasks to be completed [14]. Since the crowdsourcing was defined, this internet tool has become an effective tool in various research areas including, such as, linguistic study [15], scientific research [16], open innovation [17] and of course design research [18][19]. Based on the reported research results of

crowdsourced design, the fundamental crowdsourced design framework has been built [20]. By using crowdsourcing as an effective tool all through design stages, and the methods, for example, the Human-based Genetic Algorithms (HBGA) [21][22] for creating designs, or Crowdsourced Design Evaluation Criteria (cDEC) for design evaluation process, the quality of final design outputs can be improved.
The cDesign framework is briefly described in this sub-section. In Figure 1, it is clearly illustrated that the cDesign Framework consists of four main stages: Specification, Prototype, Execution and Evaluation. The framework is used in this paper to establish the context of the authors' investigations. Please find the authors' reported work of the every detailed process of the framework [23][20]. The next section describes the Crowdsourcing-based Design Teaching Model (CBDTM).

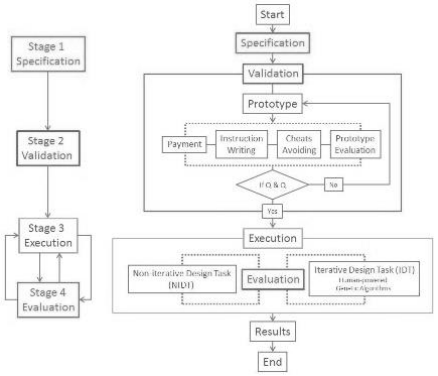

Figure 1.cDesign Framework

2 CROWDSOURCING-BASED DESIGN TEACHING WORKFLOW (CBDTW)

In this paper, because usually internet crowd workers would spend at least 24 hours to create only one generation design results or evaluate one generation of designs[24], to decrease the unnecessary waiting time for both students and lecturers, the authors treat the students in the classroom as a 'micro-crowd'. This 'micro crowd' is formed by undergraduate design students. From authors' previous research work, over 70% participants having no design experience [20][23]. Compared with those crowd workers, although undergraduate design students have been educated by the knowledge in design domain, they lack design practice (i.e., industrial design projects). So, these undergraduate design students are semi-professional designers, and could be treated as the 'micro-crowd' in crowdsourcing. Besides, a big difference between 'micro-crowd' and real crowd worker is that design students will not be paid. After defined the internet crowd, the crowdsourcing platform is defined as the design classroom which is consisted by 'micro-crowd'. So, defined the crowd and platform, based on the cDesign framework, the CBDTW is shown in Figure 2.
In Figure 2, the CBDTW is structured by four main stages: Introduction to Students, Design Specification, Conceptual Design and Design Evaluation. In the teaching workflow, the first stage (orange coloured in Figure 2) to students is an introduction of internet crowdsourcing, crowdsourced design and process. Then in stage 2 (deep blue coloured), because students are treated as crowd, lecturer could separate them into groups to start design process. Each group of students is given a design task (i.e., please design a family-use electronic product, students can fix the exact product by their own). To create design specifications, each group provide 1 to n pieces of specifications, then groups swop their specifications to other groups to create more pieces of specifications based on the previous specifications. This method is familiar with Crowdsourced Design Evaluation Criteria (cDEC) method [20] [22] [25], the difference is that the online crowd is replaced by the undergraduate design students. So, design specification in CBDRW is called 'micro-crowd' cDEC. When finishing the specification creating process, each group integrated the 'micro-crowd' cDEC and started the conceptual design in stage 3 (purple coloured). In this stage, each group generated their first generation of conceptual designs (1 to n designs). Then students swop their first-generation designs to other groups to evaluate them by 'micro-crowd' cDEC (stage 4, green coloured). Then each group analysed the evaluation results to create the second generation of conceptual designs (repeat stage 3 and then stage 4).

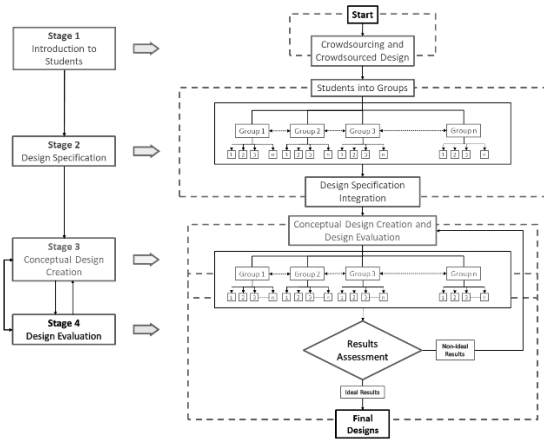

Figure 2. Stages and detailed process of CBDTW

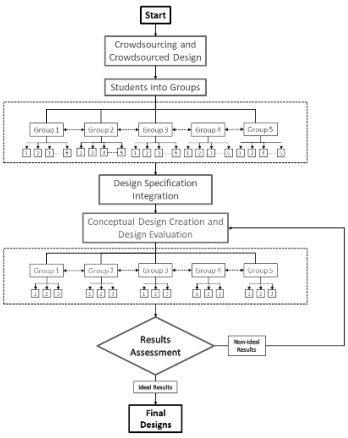

Figure 3. Main workflow of design teaching case study

When lecturers and students achieved the ideal design results, or the lecture is ending, the design and evaluation will stop.

The purpose of applying CBDTW to undergraduate design students is to introduce crowdsourcing design method and cDesign Framework as one of the latest design research results. Students could experience the fresh design methodology and practice in the class during a limited teaching time compared with the traditional design teaching. In the next section, a case study of CBDTW in real lecture is shown.

3 A CASE STUDY OF CBDTW

To practice the CBDTW in real class, the authors firstly gave the design students (2nd year industrial design students – average age in 20.5, 16 females and 10 males – in the Department of Industrial Design, School of Manufacturing Science and Engineering, Sichuan University, China) an introduction of the internet, the definition and development of crowdsourcing technology, crowdsourced design, cDesign Framework and the application of crowdsourcing in design. Then students were separated into 5 groups (Group 1 had 6 students, Group 2 to Group 5 had 5 students in each). The main workflow in this case study is illustrated below (in Figure 3).

Firstly, in each group, the 'micro crowd' was required to design a smart or intelligent product (students could fix their exact design tasks by themselves after the group discussion). Secondly, students were asked to create the cDEC by the question 'Please provide the best and the most essential features of XXXX (product's name, i.e., mobile-phone or smart watch), each group member providing one feature'. Then each group should swap their specifications to other groups, till all the rest groups provide design specifications to the design task. Thirdly, based on the 'micro crowd' design specifications (also was the cDEC), each group were required to generate three conceptual designs. Fourthly, groups swopped their conceptual designs and evaluated them by the cDEC. Each group should provide three suggestions to each design. Then repeat the conceptual design generation and design evaluation process. The next section shows the design results by applying the CBDTW.

4 RESULTS AND DISCUSSIONS

This section illustrates the students design results based on the CBDTW.

Group 1, 'Smart Take-away Package'.

Students collected design specifications (cDEC), for example, keeping the food hot, easy-washing, eating time reminder, inner heating function, connect to mobile phone by an app, etc. Based on those specifications, Figure 4 shows the first-generation designs, and Figure 5 shows an example of the final designs based on the evaluation suggestions.

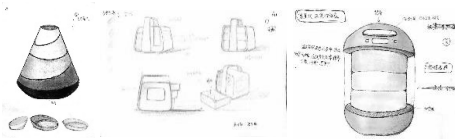

Figure 4. Design results examples from Group 1

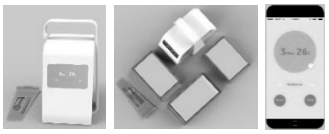

Figure 5. Examples of final designs of Group 1

Group 2, 'Air Humidifier'.

The design specification of group 2 were, for example, humidity test, easy handle, air clean, mobile APP control, etc. Figure 6 shows some examples of the first-generation designs, and Figure 7 shows an example of final output based on the evaluation suggestions.

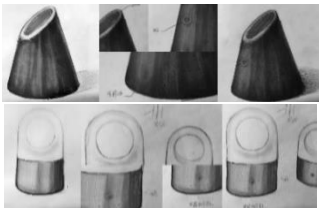

Figure 6. Group 2 first generation designs

Figure 7. Examples of final designs of Group 2

Group 3, 'Intelligent Wight'

Design specification (cDEC) in group 3 were, for example, flipped design, light, app connection, smart weight data analysis of family members, etc. Figure 8 shows some examples of the first-generation sketches. And Figure 9 are an example of final designs.

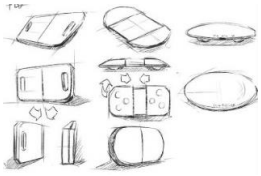

Figure 8. Group 3 first generation sketches

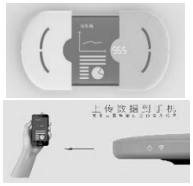

Figure 9. An example of final designs in Group 3

Group 4, 'Smart Modularisation Design Flowerpot'

The design specifications of group 4 design task were, for example, changeable colour, earth soil test, watering reminder, modularisation design, etc. Figure 10 shows examples of the first-generation sketches, and Figure 11 shows an example of final designs.

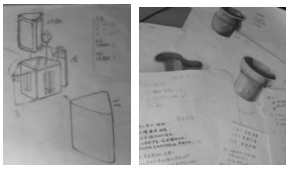

Figure 10. Examples of Group 4 first generation designs

Figure 11. An example of final designs in Group 4

Group 5, 'Chocolate Bread - Kitchen Music Speaker'

Group 5 collected the following design specifications (cDEC): voice control, timer, kitchen harmful gas monitoring (i.e., C.O.), etc. Figure 12 shows examples of the first-generation sketches, and Figure 13 shows an example of final designs.

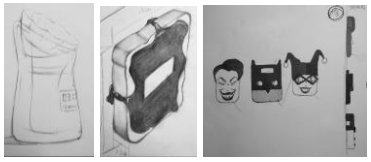

Figure 12. Group 5, examples of the first-generation sketches

Figure 13. An example of the final designs in Group 5

After applying the CBDTW in design teaching, students – the "micro crowd' – experienced the crowdsourcing technology as a design tool which helped students to create, evaluate and improve designs. Students applied crowdsourcing to generate design concepts, evaluate designs, improve designs and collaborate with group members. Obviously, compared with the first-generation sketches, it can be observed that the final designs were improved.

5 CONCLUSION, LIMITATION AND FUTURE WORK

In this paper, the Crowdsourced-based Design Teaching Workflow (CBDTW) is described, and a case study applying the CBDTW is discussed. The second-year undergraduate design students used the CBDTW to generate designs into different groups. Crowdsourcing technology was introduced to students in design teaching to practice their design learning and skills (i.e., free-hand sketching, 3D modelling and rendering). However, this paper has limitations. For instance, students did not record the detailed developed sketches of each generation of conceptual designs, and the final designs were not evaluated by statistical analysis methods with a control group. Moreover, design education and its practice is a long-term process. In the future, the authors could keep developing the CBDTW, and collect more design evaluation data for the statistical analysis.

ACKNOWLEDGMENT

Thank all year 2020 undergraduate students from the Department of Industrial Design in Sichuan University, thank you very much for your hard work during the lecture, and the strong support to the authors (Figure 14, a photo of students' group work applying CBDTW).

Figure 14. A photo of students' group work

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