S.A.D in Education and CHEER in Practice: A Case Study of DTIT Program at NTUA

John Kreifeldt[1], Hong-lin Li[2], Ming-Xean Sun[3], Wei Bi[4], and Rungtai Lin[5(✉)]

[1] Tufts University, Medford, MA, USA
john.Kreifeldt@tufts.edu
[2] Department of General Education,
National Taiwan University of Arts, New Taipei City, Taiwan
larryli@ntua.edu.tw
[3] Institute of Applied Arts, National Chiao Tung University, Hsinchu, Taiwan
buddasfox@gmail.com
[4] Graduate School of Creative Industry Design, College of Design,
National Taiwan University of Arts, New Taipei City, Taiwan
beebvv@qq.com
[5] Taiwan Design Center, Taipei, Taiwan
rtlin@tdc.org.tw

Abstract. Recently, the growth of Taiwan's graduate education in design fields has boomed. There are a number of well-established design programs in universities ranging from undergraduate to postgraduate and even doctoral level. In the past, the main concern was about the "capability" of design rather than the "power" of design. Currently, there are projects in Taiwan involving academia, industry and government agencies, which is an encouraging phenomenon. By blending Science, Arts and Design (S.A.D), we can bridge the gap between academia and industry to reach Collaboration, Humanity, Empathy, Ecology and Renaissance (CHEER). Therefore, this study intends to explore the relationship between SAD in education and CHEER in practice through a case study of the DTIT (Design Team In Training) program at National Taiwan University of Arts (NTUA). Results presented herein help us create an approach to examine the manners designers transform S.A.D as well as the interwoven experience of CHEER in design process. In addition, this study presents a paradigm to integrate ergonomic considerations into human performance in "pleasure" for keyboard design. In a word, we suggest that S.A.D in education and CHEER in practice through the DTIT program would be validated through more testing and evaluating in further studies.

Keywords: SAD in education · CHEER in practice · Cross-culture design
Interdisciplinary

1 Introduction

Recently, the prosperous growth of Taiwan's design has attracted international design masters to visit the island to witness the rise of our design industry. Some people like Philippe Starck [1] propose that Taiwan should foster design talents. In the OEM era,

P.-L. P. Rau (Ed.): CCD 2018, LNCS 10912, pp. 160–171, 2018.
https://doi.org/10.1007/978-3-319-92252-2_12

Taiwan manufacturers were busy developing products to meet manufacturing deadlines; there was no time for them to enhance design capabilities, so how could such an environment nurture design talents? [2] Therefore, another voice came out: "Taiwan needs to foster good design teams." Although Taiwan had no international design masters in recent years, the fight for survival in the global market has driven Taiwan enterprises to incubate design teams, design studios, and even design companies to promote the development of Taiwan design [3].

The importance of team-work among designers and those in other disciplines cannot be underestimated. On one hand, each member of the collaboration teams can contribute in his/her own field such that designers can focus on the creation of art forms, usability experts can work on usability assessment and user feedback, marketers can help satisfy the needs of customers for products, etc. In particular, a relatively large and complex product/service often requires a team consisting of industrial designers, usability engineers, marketers, systems engineers, developers, and testers [4]. On the other hand, while the design of products has been the primary focus of training and practice of design education in Taiwan, service design has not been considered as part of the design domain. This is true of Taiwan and is also mostly true of the global design community. As the use of Internet services mushrooms, and governments and companies have increasingly relied on the Internet for their sales and services, the design of services has gained more deserved attention. Even though the design of services is rather different from the design of products, the two share common science principles, art esthetics and design methodologies [4, 5].

To collaborate between design and other disciplines, we would also emphasize the benefits that can be derived from joint projects between industry and academia. Currently, there are projects in Taiwan involving academia, industry and government agencies, which is an encouraging phenomenon [4]. Design education through joint design projects originating from the combination of the real and the virtual worlds is not a new approach. Therefore, it is important that a wider range of experience should be incorporated into the design approach. In this study, we introduce the basic ideas of SAD in education and CHEER in practice to underlie the approach to the DTIT program in NTUA as well as the application of SAD to achieve CHEER.

2 SAD in Design Education – Design Team in Training Program

Over the last few years, we have witnessed the growth of Taiwan's postgraduate education in design fields. There are numerous well-established design programs in universities ranging from undergraduate to postgraduate and even doctoral degrees. In the past, the main concern was about the "capability" of a design rather than the "power" of a design. In view of this, the National Taiwan University of Arts (NTUA) established an art museum, known as "Our Museum" in 2007 in order to achieve the purpose of linking professional teaching with design research, education, and display while presenting cultural and aesthetic ideas about arts and artifacts to the public [6, 7]. Developing craftsmanship and creativity as well as competences related to the arts are of strategic importance to NTUA. In addition, a plan called 'ABCDE' was conducted

to transform “Arts” to “Business”, to integrate “Creativity” and “Design”, and, furthermore, to put the content into ‘E-commerce’ to build the link with the market [8–10]. Therefore, a design studio, known as “Our Studio”, was set up at the College of Design at NTUA following the “Our Museum” to provide innovative products. Due to the challenging nature of cultural and creative industries, NTUA is devoted to developing its regional and international networks by operating a cultural and creative industry park, known as “Our Factory” [11, 12]. NTUA has established the link between “Arts and Business” and combined “Creativity” and “Design” through Our Museum, Our Studio, and Our Factory respectively. It is a new approach that integrates design, culture, artistic craftsmanship, creativities and service innovation design in cultural and creative design industries [6, 7, 13].

Internship programs have multiple potential benefits. First, students gain the experience of working in the real world by developing business-oriented design projects and therefore they could better relate what they learn at school to what they will do after graduation. Second, the internship experience can also lead to future employment which can also be viewed as benefiting companies that provide internship opportunities [4]. Given the importance of internship experience, we need to review critically whether the current design educational programs meet the needs of the society and the professional requirements of designers. In order to satisfy these needs, we should bridge “the last mile” between universities and enterprises for design practice, which is to boost not only the capability but also the power of design [4]. To this end, NTUA established a two year program called “Design Team in Training” (DTIT) at a graduate institute school, which was promoted by recruiting a design team of students and then seeking a supporting enterprise. Shneiderman [14] used three elements S, E, and D to achieve breakthrough collaborations in the new ABCs of research, where S, E, and D designate Science, Engineering, and Design. Similarity, by combining Science, Arts, and Design (SAD), DTIT can produce a higher impact on design education by bridging the gap between academia and enterprise as shown in Fig. 1.

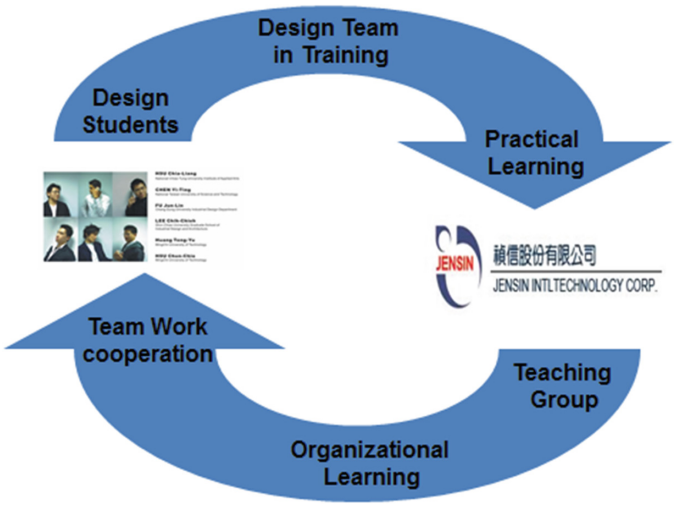

Fig. 1. A framework of design team in training (DTIT)

DTIT integrates the concept of SAD in training and education. In the first year, a design competition is used to help the design team learn how to work together. They will select design contests, both domestic and international, as design problems and then work cooperatively on them. In the second year, the team identifies an internal design problem, and works together to solve it, which helps the team develop new skills, including technology, manufacture, and marketing. At this stage, the team is working on the real-world problems instead of simply receiving instruction in classrooms. Regular meetings between the student design team and the teaching group are conducted for each student's needs to be evaluated and a personalized study plan to be setup or regularly reviewed. Which projects to work on, what courses to take, and which professional internships to consider can all be discussed. This process can not only make students' studies more productive and reassuring but also ensure a more successful career for them in the future [4].

3 CHEER in Design Practice – Designing 'Cheerful' into Keyboard

When a designer starts to design a new product, he or she needs to integrate many demands, wants and desires that prospective users of the product may have. Specifically, not only should technical and objective demands be tackled, but also aesthetic, emotional, and other experiential factors, some of which are hard or impossible to express objectively, should be attended to in design [15–18]. Thus, in the practice of design, the designer has to strike a balance between functional technology and emotional expressiveness to satisfy the requirements of the product. This study proposes that by combining Science, Arts and Design (SAD) we can produce a higher impact on design practice to reach Collaboration, Humanity, Empathy, Ecology, and Renaissance (CHEER).

The property "cheerful", which is pleasure, enjoyment, and fun, is the quale to emotional design [19, 20]. As the Greek philosopher Epicurus wrote in his Letter to Menoeceus, "We recognize pleasure as the first good innate in us, and from pleasure we begin every act of choice and avoidance, and to pleasure we return again, using the feeling as the standard by which we judge every good." [17, 18, 21]. Even given the growing interest of Human-Computer Interaction (HCI) research in how to achieve pleasure and fun as the goal of computer peripheral products [22], designers are far from having a deep understanding of what enjoyment actually is and how it can be designed "cheerfully" into products [23–25]. Let us take computer keyboards as an example: many people want more feedback from the pleasing feel of the keys on many laptop computers as well as keyboards.

Ergonomic considerations are very important to keyboard design, since people undertake a large number of activities and spend most of their time on computers. The most important ergonomic consideration for designing daily-life products is "designing for human use", while a concept emerging as a new human factor is "designing for human feel" [26, 27]. Feel is the most intimately bound up in "pleasure" as well as "pain", and would seem to be a legitimate subject of investigation if one wishes to produce a pleasant product [16, 28, 29]. Jordan [30] noted that usability as a concept does not seem to include positive feelings such as pride, excitement, or surprise. He

added that caring about positive emotions is not reflected in traditional human factor practices. In the context of products, "pleasure" can be defined as "pleasure with products" – the emotional, hedonic and practical benefits associated with products [31]. It is important to note that pleasure with products comes from the relationship between users and products. Pleasure, then, is not simply a property of a product but an interaction between a product and a person [32, 33].

A designer might question whether designing for fun, pleasure and enjoyment is a desirable goal and whether the processes and topics involved differ in any significant way from designing for usability [25]. Beyond usability, pleasure would be one of the major feelings from the impression obtained by emotional design. However, when designing products, designers are concerned with not only the visual appearances but also the other properties of the product. Object content as well as context are considered. Designers give their attention to the behaviors of users when they perceive images or products and study how their personal preferences or cultural differences relate to their feelings [34].

Taiwanese people reportedly averaged 42.6 h in using computers and the Internet each week. In other words, people spend a large amount of time using mice, keyboards, or other input devices which provide people with an interface to interact with the computer system. As motioned above, the DTIT program conducted a project of designing a "pleasure keyboard" and a "usability keyboard" by addressing ergonomic considerations. Mings' design team worked on the real-world problem in place of receiving classroom instruction. First, the team identified a focus of internal design, including technology, manufacture, and marketing. In particular the core technology of Jensin International Technology Corp in flexible printed circuit, membrane switch, and plastic injection is taken into the designing process. As the next step, the team worked together to develop new ideas and design for a new keyboard of "pleasure" and "usability" in the designing process, including product analysis, marketing research, concept developing, design evaluation, mock-up, and mass production, as shown in Fig. 2.

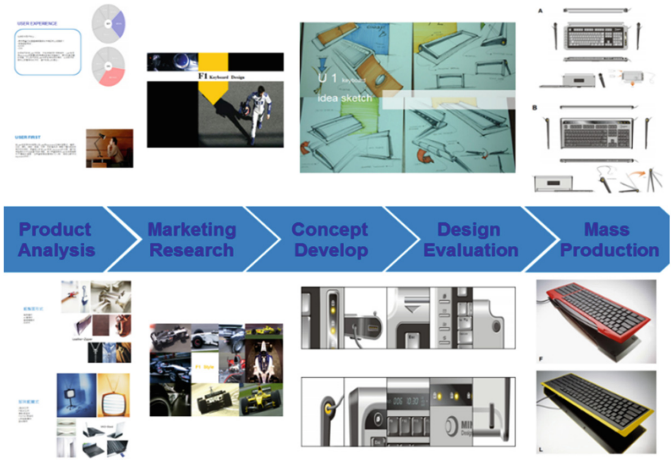

Fig. 2. The process of designing usability and pleasure into a keyboard

In the design process, with the benefit of collaboration from various team members, careful considerations should be given to the design's feasibility, usability, Kansei engineering, and marketability, so that the new design will enhance and enrich user needs of pleasure and usability. We believe that a design concept is more likely to become a successful consumer product if there is collaboration from relevant design consideration throughout the entire product design process – from design concept to final product. Figure 3 shows the final design for usability consideration, and Fig. 4 illustrates the emotional design for infusing pleasure into the keyboard.

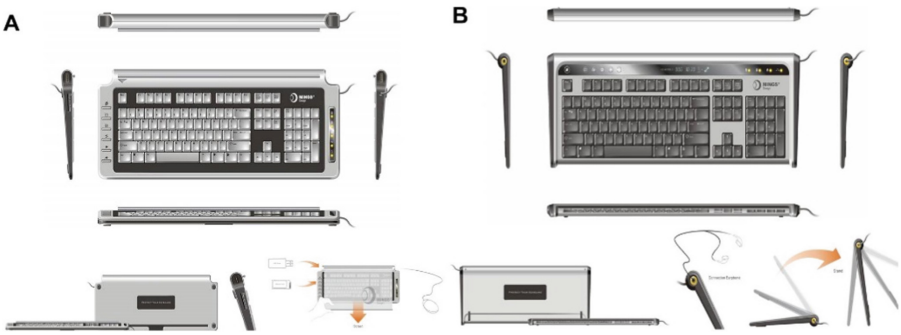

Fig. 3. Keyboard design for usability consideration

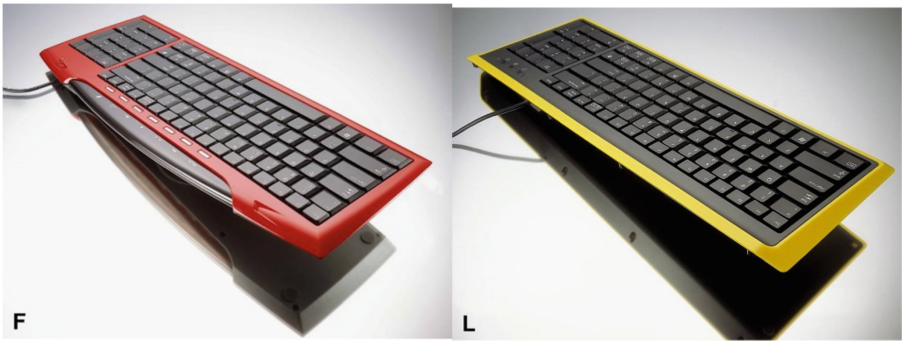

Fig. 4. Designing pleasure into the keyboard

4 Validation of CHEER in Design Practice

4.1 A Questionnaire-Based Evaluation Checklist

The use of a questionnaire-based checklist is a convenient evaluation method because it is relatively undemanding of time and facilities. The evaluation checklist provides an effective way of gaining an overview of users' responses to a product [35]. Therefore, an evaluation checklist was used to evaluate the potential reactions that a user may have

to the keyboard design. The participants were asked to mark against the reactions that they had or that they anticipated that they would have to a keyboard. Based on the Jordon's research [31], the list of potential reactions could include those in all four pleasure categories: physiological pleasure, psychological pleasure, sociological pleasure, and ideological pleasure, depending on the keyboard design. The evaluation checklist is shown in Fig. 5 where participants can indicate the reactions that they have when experiencing each keyboard design.

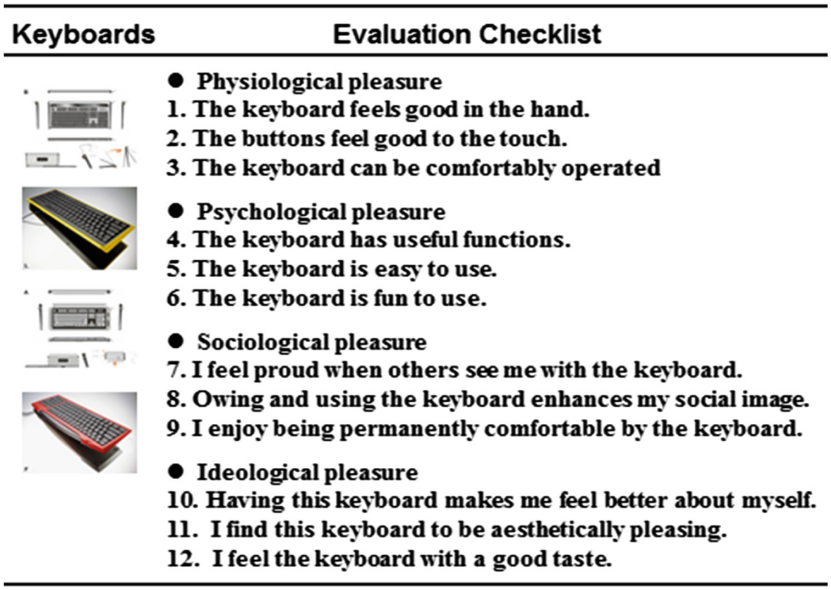

Fig. 5. The evaluation checklist for keyboard designs

4.2 Stimuli

The stimuli consisting of 4 keyboard designs were constructed for the DIIT program. One condition presented the design characterizing the infusion of "usability" into the keyboard (Fig. 3), the other demonstrated the design profiling "feeling" for the keyboard (Fig. 4). The 4 keyboards were designed by Mings' Design Team, which were the fruit of the design project of the DTIT program supported by the Jensin International Technology Corp.

4.3 Participants

All participants were university students who volunteered from the northern and southern regions of Taiwan. A total of 179 participants, composed of 77 males (43%) and 102 females (57%) covering the ages of under 30 (65%), 31–50 (27.2%), and above 50 (7.8%), took part in the study. The majority of the participants came from

design-related departments (83/46.1%), followed by departments in business and management (63/35%) and others (33/18.9%). Participants were informed of the purpose of the experiment, and were requested to report information including their age, gender, and background. An introduction and product pictures of the keyboard designs were presented and participants were asked to rate each keyboard design according to the degree of association as specified on a five-point Likert scale in the evaluation checklist. The questionnaire was established on the website: https://docs.google.com/forms/d/e/1FAIpQLSdKyvxqmbaixQ-HQNR55elJjjrsQUvXYxqOpkp2l3a4L_ktrQ/viewform.

4.4 Results

Table 1 summarizes the rating data of performance in all four pleasure categories, depending on the four keyboard designs. The paired t-test results show that the average rating of keyboard L is significantly higher than that of keyboards A, B and F. For all the keyboard designs, the average rating of physiological and psychological pleasure is significantly higher than that of sociological and ideological pleasure. Thus, the factors of usability (e.g. physiological pleasure) are more tangible than those of emotion (e.g. ideological pleasure).

Table 1. Experimental subjects

Evaluation Checklist	N	Keyboard A		Keyboard B		Keyboard F		Keyboard L	
		mean	s.d.	mean	s.d.	mean	s.d.	mean	s.d.
Phys. 1	179	3.07	1.02	3.15	1.01	3.35	0.97	3.66	0.83
Phys. 2	179	3.11	0.98	3.04	0.98	3.41	1.00	3.64	0.82
Phys. 3	179	3.09	0.99	3.13	0.98	3.33	1.00	3.65	0.83
Psyc. 4	179	3.42	0.94	3.28	0.99	3.50	0.92	3.60	0.87
Psyc. 5	179	3.18	1.07	3.21	1.04	3.63	1.00	3.73	0.81
Psyc. 6	179	3.06	1.05	3.01	1.00	3.08	1.13	3.24	1.00
Soci. 7	179	2.95	1.08	2.90	1.05	2.78	1.22	3.07	1.14
Soci. 8	179	2.78	1.05	2.81	1.09	2.64	1.22	3.02	1.17
Soci. 9	179	2.89	1.04	2.88	1.07	3.04	1.12	3.24	1.07
Ideo. 10	179	2.76	1.04	2.84	1.11	2.66	1.11	3.09	1.13
Ideo. 11	179	2.80	1.10	2.81	1.15	2.90	1.29	3.27	1.10
Ideo. 12	179	2.78	1.13	2.84	1.12	2.89	1.28	3.23	1.11
AorB-13	179	A:36% / B:64%							
ForL-14	179						L:63% / F:37%		
Most-15	179	A:16% / B:16% / L:45% / F:23%							

Furthermore, three questions were asked as follows. Question (13) asked: “In the comparison of keyboards A and B, which one do you prefer?” Question (14) asked: “In

the comparison of keyboards F and L, which one do you prefer?" Question (15) asked: "In the comparison of all the keyboards A, B, F and L, which one do you prefer?"

For the comparison of keyboards A and B, 115 (64%) participants prefered keyboard B to keyboard A (64/36%), while keyboard L (113/63%) was more preferable relative to keyboard F (66/37%). The paired t-test results show that the average rating of keyboard B is significantly higher than that of keyboard A, and that of keyboard L is significantly higher than that of keyboard F. For the comparison of all the keyboard designs, keyboard L gains the highest preference rating by participants (80/45%) in contrast to keyboard F (41/23%), keyboard A (29/16%), and keyboard B (29/16%). The rating results indicate that the effects of "usability" versus "pleasure" keyboards are split in cross-category comparison. Thus, an in-depth study should be executed to explore the distinct impacts of perception between usability and pleasure.

4.5 Discussion

As alluded to above, Mings' Design Team was asked to design keyboards using the difference approach of "usability" and "pleasure". The U1 keyboard was a design based on the definition of "usability" as "the effectiveness, efficiency and satisfaction with which specified users can achieve specified goals in particular environments" (ISO DIS 9241-11). The traditional ergonomic considerations, as tackled in product analysis, marketing research, concept develop, design evaluation, mock-up making, and mass production, were used in the design process as shown in Fig. 6. Beyond the ergonomic consideration, designing "pleasure" into products is a concept of designing for human emotion [16, 36]. "Pleasure", as the Oxford English Dictionary defines, denotes "the condition of consciousness or sensation induced by the enjoyment or anticipation of what is felt or viewed as good or desirable; enjoyment, delight, gratification." Along this line of reasoning, the F1 keyboard design was created based on the emotional, hedonic, and practical benefits associated with the product [30, 31]. That is to say, by using the image of the F1 racing car, the design team was trying to convey the feelings of effectiveness, efficiency, and satisfaction, which are the key factors in usability as shown in Fig. 7.

Fig. 6. Usability in keyboard design

Fig. 7. Pleasure in keyboard design

Based on Table 1, the design of keyboard L obtained the highest rating score in the checklist and the highest preference value from the subjective rating. This result finds support from the design competition: The design of keyboard L won the 2006 Japan G-mark award, and received the comment from the jury – original, appealing, fresh, and creative life experience's design.

5 Conclusions and Recommendations

Tradition does play a big role in the characteristics of design education. This is true when it comes to design programs in Taiwan. On the other hand, design thinking, design philosophy, material, technology, etc., are also changing over time. All these factors can impact design educational programs [36]. In the traditional education system, students have been required to study sciences and arts at a relatively early age. Recently, educational reformation has been proceeding, and the concept STEM (as the acronym of Science, Technology, Engineering, and Mathematics) has been adopted by numerous programs as an important focus for renewed global competitiveness [15, 37]. As a follow-up on STEM, a theoretical model for education - STEAM has been proposed for science educators and curriculum developers: STEAM being the the acronym for Science, Technology, Engineering, Arts, and Mathematics [38]. In design research, Shneiderman [14] used three elements S, E, and D to "achieve breakthrough collaboration". The A, B, and C in the title of his work stand for "applied and basic combined", whereas the elements of S, E, and D, as he proposed, designate "science, engineering, and design".

Sciences and arts education have already been established in the general education system. However, design in general education has been a missing "third area". Therefore, this study proposes an approach to build an interdisciplinary connection between "SAD" in design education and "CHEER" in design practice. For SAD to be realized in education, we conducted the DTIT program, and we believe that a much broader, different, interdisciplinary training, above and beyond artistic talents, is in order for contemporary designers in Taiwan. In addition, since we recommend collaboration between designers and other professionals, a design project of designing "pleasure" into keyboards was carried out through the DTIT program.

Results presented herein have helped us create an approach to examine the manner in which designers apply and embody the idea of SAD as well as the interwoven experience of CHEER in design process. In addition, this study offers a paradigm to integrate ergonomic considerations into human performance in "pleasure" for keyboard design. Finally, the notions of SAD in education and CHEER in practice manifested through the DTIT program would be validated through more testing and evaluating in further studies.

Acknowledgements. The authors would to thank Mr. Fong-Chi Hsu, the President of Jensiin International Technology Corp. for funding this study. Special thanks should go to Mings' Design Team for joining the DTIT program at NTUA and designing the keyboards for the purpose of this study.

References

1. http://www.starck.com/en (2017)
2. Lin, R., Kreifeldt, J., Hung, P.H., Chen, J.L.: From dechnology to humart – a case study of Taiwan design development. In: Rau, P. (ed.) Cross-Cultural Design Methods, Practice and Impact, vol. 9181, pp. 263–273. Springer, Heidelberg (2015). https://doi.org/10.1007/978-3-319-20934-0_25
3. Hsu, C.H., Chang, S.H., Lin, R.: A design strategy for turning local culture into global market products. Int. J. Affect. Eng. **12**(2), 275–283 (2013)
4. Tsao, Y.C., Lin, R.: Reflections on the training and practice of industrial design in Taiwan. In: Proceedings of 2011 IDA Congress Education Conference, pp. 87–94. Taiwan Design Center, Taipei (2011)
5. Lin, R., Yen, C.-C., Chen, R.: From adaptive design to adaptive city-design in motion for Taipei city. In: Rau, P.L.P. (ed.) CCD 2014. LNCS, vol. 8528, pp. 643–649. Springer, Cham (2014). https://doi.org/10.1007/978-3-319-07308-8_61
6. Lin, R., Chen, C.T.: A discourse on the construction of a service innovation model: focus on the cultural and creative industry park. In: Ifinedo, P. (ed.) EBUSINESS – Application and Global Acceptance, pp. 119–136. InTech, Croatia (2012)
7. Lin, R., Lin, C.L.: From digital archives to E-business: a case study on turning "art" into "business". In: Proceedings of the 2010 International Conference on e-Business (ICE-B), pp. 1–8. IEEE (2010)
8. Hsu, C.H., Fan, C.H., Lin, J.Y., Lin, R.: An investigation on consumer cognition of cultural design products. Bull. Japan. Soc. Sci. Des. **60**(5), 39–48 (2014)
9. Hsu, C.H., Lin, C.C., Lin, R.: A study of framework and process development for cultural product design. In: Rau, P.L.P. (ed.) HCII 2011. LNCS, vol. 6775, pp. 55–64. Springer, Heidelberg (2011). https://doi.org/10.1007/978-3-642-21660-2_7
10. Ko, Y.Y., Lin, P.H., Lin, R.: A study of service innovation design in cultural and creative industry. In: Aykin, N. (ed.) IDGD 2009. LNCS, vol. 5623, pp. 376–385. Springer, Heidelberg (2009). https://doi.org/10.1007/978-3-642-02767-3_42
11. Lin, R.: Transforming Taiwan aboriginal cultural features into modern product design-a case study of cross cultural product design model. Int. J. Des. **1**(2), 45–53 (2007)
12. Lin, R., Lin, P.H., Shiao, W.S., Lin, S.H.: Cultural aspect of interaction design beyond human-computer interaction. In: Aykin, N. (ed.) IDGD 2009. LNCS, vol. 5623, pp. 49–58. Springer, Heidelberg (2009). https://doi.org/10.1007/978-3-642-02767-3_6
13. Lin, R.: Designing friendship into modern products. In: Toller, J.C. (ed.) Friendships: Types, Cultural, Psychological and Social, pp. 1–23. Nova Science Publishers, New York (2009)
14. Shneiderman, B.: The New ABCs of Research: Achieving Breakthrough Collaborations. Oxford University Press, Oxford (2016)
15. Breiner, J.M., Harkness, S.S., Johnson, C.C., Koehler, C.M.: What is STEM? A discussion about conceptions of STEM in education and partnerships. Sch. Sci. Math. **112**(1), 3–11 (2012)
16. Kreifeldt, J., Lin, R., Chuang, M.C.: The importance of "feel" in product design feel, the neglected aesthetic "DO NOT TOUCH". In: Rau, P.L.P. (ed.) HCII 2011. LNCS, vol. 6775, pp. 313–322. Springer, Heidelberg (2011). https://doi.org/10.1007/978-3-642-21660-2_35
17. Monk, A., Hassenzahl, M., Blythe, M., Reed, D.: Funology: designing enjoyment. In: Extended Abstracts on Human Factors in Computing Systems, CHI 2002, pp. 924–925. ACM (2002)

18. Monk, A., Lelos, K.: Changing only the aesthetic features of a product can affect its apparent usability. In: Monk, A., Lelos, K. (eds.) IFIP TC 9, WG 9.3 HOIT 2007. IFIP, vol. 241, pp. 221–233. Springer, Heidelberg (2007). https://doi.org/10.1007/978-0-387-73697-6_17
19. Crilly, N., Moultrie, J., Clarkson, P.J.: Seeing things: consumer response to the visual domain in product design. Des. Stud. **25**(6), 547–577 (2004)
20. Djajadiningrat, J.P., Overbeeke, C.J., Wensveen, S.A.: Augmenting fun and beauty: a pamphlet. In: Proceedings of DARE 2000 on Designing Augmented Reality Environments, pp. 131–134. ACM (2000)
21. Long, A.A.: Hellenistic Philosophy: Stoics, Epicureans, Sceptics. University of California Press, Berkeley (1986)
22. Ma, J.P., Wei, S., Lin, R.: Designing cloud computing into Taipei city: a pilot study of the service design from Taipei cloud. In: Rau, P.L.P. (ed.) CCD/HCII 2014. LNCS, vol. 8528, pp. 688–695. Springer, Heidelberg (2014). https://doi.org/10.1007/978-3-319-07308-8_66
23. Hassenzahl, M., Burmester, M. Beu, A.: Engineering joy. IEEE Softw. **1**(2), 70–76 (2001)
24. Hassenzahl, M., Tractinsky, N.: User experience-a research agenda. Behav. Inf. Technol. **25** (2), 91–97 (2006)
25. Hollnagel, E.: Keep cool: the value of affective computer interfaces in a rational world. In: Proceedings of the HCI International 1999, vol. 2, pp. 676–680 (1999)
26. McGinley, C., Dong, H.: Designing with information and empathy: delivering human information to designers. Des. J. **14**(2), 187–206 (2011)
27. McLoone, H., Jacobson, M., Goonetilleke, R.S., Kleiss, J., Liu, Y., Schütte, S.: Product design and emotion: frameworks, methods, and case studies. In: Proceedings of Human Factors and Ergonomics Society Annual Meeting, vol. 56, no. 1, pp. 1940–1941. SAGE Publications, Thousand Oaks, September 2012
28. Yen, H.Y., Lin, C., Lin, R.: A study of applying Qualia to business model of creative industries. In: Rau, P.L.P. (ed.) CCD 2013. LNCS, vol. 8023, pp. 148–156. Springer, Heidelberg (2013). https://doi.org/10.1007/978-3-642-39143-9_17
29. Yen, H.Y., Lin, P.H., Lin, R.: Emotional product design and perceived brand emotion. Int. J. Adv. Psychol. (IJAP) **3**(2), 59–66 (2014)
30. Jordan, P.W.: Human factors for pleasure in product use. Appl. Ergon. **29**(1), 25–33 (1998)
31. Jordan, P.W.: Designing Pleasurable Products: An Introduction to the New Human Factors. CRC Press, Boca Raton (2002)
32. Lottridge, D., Chignell, M., Jovicic, A.: Affective interaction: understanding, evaluating, and designing for human emotion. Rev. Hum. Factors Ergon. **7**(1), 197–217 (2011)
33. Ma, J.P., Huang, N.L., Chuang, M.H., Lin, R.: From dechnology to humart. In: Rau, P. (ed.) CCD 2015. LNCS, pp. 348–360. Springer, Heidelberg (2015). https://doi.org/10.1007/978-3-319-20934-0_33
34. Lee, S., Harada, A., Stappers, P.J.: Pleasure with products: design based on Kansei. In: Pleasure with Products: Beyond Usability, pp. 219–229 (2002)
35. Ma, J.P., Lin, M.T., Lin, R.: Affective fusion of PAD model-based tactile sense: a case study of teacups. In: CCD 2013. LNCS, vol. 8023, pp. 420–429. Springer, Heidelberg (2013). https://doi.org/10.1007/978-3-642-39143-9_47
36. Norman, D.A.: Emotional Design: Why We Love (or Hate) Everyday Things. Basic Books, New York (2004)
37. Kuenzi, J.J.: Science, technology, engineering, and mathematics (STEM) education: background, federal policy, and legislative action (2008)
38. Yakman, G.: STEAM education: an overview of creating a model of integrative education. In: Pupils' Attitudes Towards Technology (PATT-19) Conference: Research on Technology, Innovation, Design & Engineering Teaching, Salt Lake City, Utah, USA (2008)