

Creative Element Analysis of Machinery Creativity Contest Works

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Abstract—Current industry is facing the rapid development of new technology in the world and fierce changes of economic environment in the society so that the industry development trend gradually does not focus on labor, but leads the industry and the academic circle with innovation and creativity. The development trend in machinery industry presents the same situation. Based on the aim of Creativity White Paper, Ministry of Education in Taiwan promotes and develops various creativity contests to cope with the industry trend. Domestic students and enterprises have good performance on domestic and international creativity contests in recent years. There must be important creative elements in such creative works to win the award among so many works. Literature review and in-depth interview with five creativity contest awarded instructors are first proceeded to conclude 15 machinery creative elements, which are further compared with the creative elements of machinery awarded creative works in past five years to understand the relationship between awarded works and creative elements. The statistical analysis results show that IDEA (Industrial Design Excellence Award) contains the most creative elements among four major international creativity contests. That is, most creativity review focuses on creative elements that are comparatively stricter. Concerning the groups participating in creativity contests, enterprises consider more creative elements of the creative works than other two elements for contests. From such contest works, creative elements of “replacement or improvement”, “convenience”, and “modeling” present higher significance. It is expected that the above findings could provide domestic colleges and universities with reference for participating in creativity related contests in the future.

Keywords—Machinery, creativity contest, creative elements, creativity works.

I. INTRODUCTION

LABOR is no longer the sole motivity of industry in the 21st century; instead, it is the knowledge-based economy era when brain is applied to reinforce the industry foundation. Meanwhile, innovative thinking, critical thinking, or problem solving is the basic competency required for human beings in the future [1]. With constant innovation of knowledge and culture accumulation, the economic civilization has turned from knowledge-based economy to creative economy [2]. Innovative creativity is the force to advance social economy as well as the source of economic profits. Creativity is currently the development trend in the world that the global economic competition would become the competition of creativity and innovation talents [3]. Constant innovation therefore is the major force of continuous growth and sustainable management of enterprises, while creative design is the direct major factor in the innovation of enterprises. Creative design and

production could enhance the added value of enterprises and promote corporate competitiveness.

Machinery industry is the mother of industry. Nevertheless, Industrial Economics and Knowledge of Industrial Technology Research Institute (2015) revealed the low demands of intermediate industries, including machinery industry, in Taiwan that machinery presented slower development than other fields in the changing era. In order to enhance the competitiveness of machinery industry in Taiwan, city and county governments, based on the aim of Creativity White Paper, have largely encouraged creativity contests so that contestants learn to solve problems in life through practical contests. The integration of cognition in different fields and the test of skills and teamwork rapport allow contestants cultivating the creative thinking ability and creativity in various fields and the interests in exploring problems [4]. Searching for creative elements in creativity contests therefore is urgently needed for industry.

There are many studies on searching creative elements for creativity contests; however, most of them in past five years focus on the creative elements in cultural and creative industry, but few on the creative elements in engineering. For instance, Hsiao et al. [5] developed 11 creative elements of special production works, such as replacement or improvement, change of physical property, production function, and shape and size. Wei and Chang [6] mentioned the major creative elements of appearance, material, surface treatment, and color match for product design. Liang [7] divided product design creative elements into appearance structure and inner quality functional design for headlight design. Makkonen and Inkinen [8] proposed the utilization of novel value, usefulness, practicality, customization, and new knowledge for creative element evaluation. Moalosi et al. [9] indicated that creative products in culture-oriented creative product design should present man-machine interaction, aesthetics, being able to deliver the affection of objects, and product flexibility and adaptability. Research on creative elements in engineering mainly stressed on the personality traits of creativity inventors, but rarely on the creative elements of works. Moreover, because of multiple creative elements, the creative elements of works which outperformed in contests were seldom discussed, and there was no discussion about valuable creative elements for engineering creativity contests.

Accordingly, machinery creative elements are concluded for this study, and 15 creative elements for machinery product design are found by literature review and expert interview. Besides, the difference in the use of creative elements between

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creativity contest groups and different contests is understood, expecting to provide reference for creativity teaching and special production courses and to develop towards interdisciplinary multiple integration for the use in larger areas.

II. LITERATURE REVIEW

A. Implication of Creativity

Creativity is the outcome through creative ability, and creativity implies uniqueness, novelty, usefulness, appropriateness, and value [10], which allow people understanding the creativity of works. Gluck et al. [11] indicated that creativity was mostly comprehended as “unusual” and high-quality affairs. Csikszentmihalyi [12] considered that creativity was reviewed from original, valuable, and practicable ideas, actions, or products and was affected the output by individuals, subjects, and fields. The creativity implication allows people understand the creativity of works.

Creativity is usually generated through the interaction between people and environment, in which some existing concepts does not necessarily have appreciators comprehend the implication [13]. Chiu [14] pointed out distinct thinking or combination of creativity presented by college students. Such a thinking model merely partially conforms to the creativity implication mentioned in this study, but does not contain usefulness, appropriateness, and valuability so that the creativity implication cannot be completely presented. In this case, more research on creativity, in which fluency, flexibility, uniqueness and precision, insight, fluid intelligence, visual perception of art, and music improvisation are covered, is necessary [15], [16] for students more completely presenting creativity. Nevertheless, such research mostly achieves the creativity implication by the promotion of creativity, but seldom discuss the creative elements to examine the creativity implication of works. This study therefore intends to search for the creative elements for machinery product design in order to examine the creativity implication of creative works.

B. Creative Elements

Concerning the presentation of creative elements, creativity is shown on idea, shape, or solution of design tasks. Since industrial design needs to handle several product related problems, including function, shape, usage, material, and meaning, creativity performance could be multiple on solution innovation, shape image, function, technology innovation, re-interpretation of affairs, re-design of structure, form, size, tone, material texture, and composition [17], [18].

It is discovered in this study that most research discusses specific single product; the design elements considered are therefore restricted. For example, Liang [7] classified product design elements into “design elements aiming at appearance structure design” and “major elements aiming at quality functional design”, where the sub-elements were classified aiming at the bicycle light design. The creativity idea design capability scale, developed by Hsiao et al. [5], aimed to

discuss college students’ special production that the considered design elements were comparatively broader and conformed to the industrial design area. Referring to the dimensions, nine design elements better related to machinery are selected for this study, Table I.

TABLE I
 DESIGN ELEMENT CLASSIFICATION OF RESEARCHERS

Reference	Design elements
Hsiao et al., 2000 [5]	Creative thinking was divided into 1. replacement or improvement, 2. change of physical property, 3. change of chemical property, 4. product operation, 5. Size, 6. Shape, 7. quantity, 8. new use of product, 9. line layout, 10. product structure, and 11. production function.
Yuan et al., 2014 [16]	1. insight, 2. fluency, 3. problem-finding ability, 4. logic capability, 5. imagination, 6. uniqueness, 7. flexibility, 8. metaphorical thinking capability, 9. adaptability, and 10. aesthetic judgment.
Bacanl et al., 2011 [19]	1. sensibility, 2. fluency, 3. flexibility, 4. uniqueness, 5. dominance, 6. analyticity, 7. comprehensiveness, and 8. redefinition.

III. RESEARCH METHODOLOGY

A. Research Process

Based on the creative elements developed by Hsiao et al. [5], questionnaire survey is applied in this study to have experts review and the types of creative elements, which are revised and appended for final 15 creative elements for machinery product design which are further reviewed by six experts different from the creativity contest instructors to understand the practicability of the developed creative elements for machinery product design in four major creativity contests and the emphasized creative elements in each contest, as the important conclusion.

B. Research Method

In order to acquire creative elements, 10 instructors who participate in international large creativity contests are proceeded semi-structured interview in this study in order to combine the above creative elements for product design in the literature review and confirm the 15 creative elements used in this study, Table II.

TABLE II
 DESIGN ELEMENT CLASSIFICATION ORGANIZED IN THIS STUDY

Creative elements
9 creative elements selected based on the literature review: 1. replacement or improvement, 2. change of physical property, 3. change of chemical property, 4. product structure, 5. product operation, 6. appearance size, 7. appearance shape, 8. product function, and 9. new use of product. 6 design elements organized according to the expert interview in this study: 1. convenience, 2. portability, 3. modeling, 4. color, 5. texture, and 6. safety.

In order to classify and apply the 15 creative elements to actual contests, the machinery creative products in international design awards recognized by International Design Alliance (2015), including German Red Dot Award, International Forum Design Award, IDEA (Industrial Design Excellence Award), and Japan G-Mark, are classified in this study. The interview was proceeded from January to March in 2015, and the number of interviewed experts and the interview

time are organized in Appendix 1, where the internal consistency Kendall coefficient of experts appears 0.799, revealing good consistency among scorers.

IV. RESULT AND DISCUSSION

The expert interview results show the works with creative elements in the creativity contests and the proportion of creative elements, Table III; and, such creative works with more than 50% creative elements in three creativity contests are mainly discussed in this study.

TABLE III
 ORGANIZATION OF CREATIVE ELEMENTS OF AWARDED CREATIVE WORKS IN
 DIFFERENT MACHINERY CONTESTS IN PAST 5 YEARS

	Red Dot (N=50)	IF (N=38)	IDEA (N=31)	G-Mark (N=22)
Replacement or improvement	50(100%)	38(100%)	27(87%)	16(72%)
Change of physical property	0	0	0	0
Change of chemical property	1	0	1	0
Product structure	48(96%)	36(94%)	27(87%)	17(77%)
Product operation	35(70%)	26(68%)	25(80%)	13(59%)
Appearance size	10	7	9	4
Appearance shape	41(82%)	24	25(80%)	16(72%)
Convenience	41(82%)	32(84%)	26(83%)	9(40%)
Portability	22	12	10	8
product function	28(56%)	26(68%)	18(58%)	6(27%)
New use of product	4	3	7	3
Modeling	42(84%)	28(73%)	28(88%)	20(90%)
Color	14	5	15	18
Texture	6	3	6	8
Safety	17	13	12	2

In the creative product production process, replacement or improvement is the problem solving process using brand-new models and application of old methods to produce products with originality and value [20]. K.L. Chang, the Red Dot Award review committee, also revealed that the quality, originality, and replacement and improvement of works were the factors in winning awards [21] and about 26% innovative creativity in current creative invention was replacement or improvement [22]. Apparently, the significance of replacement or improvement is emphasized in various contests.

In terms of product operation, the US IDEA review criteria mentioned that innovative experiences under innovation would enhance users' consumption desire as well as allow users immersing in the flow of finding out novel affairs [23]. For this reason, product operation is also an important creative element in contests.

The relevant research revealed the involvement of a lot of product structure in human factor engineering research. Human factor design could reduce accident and injury risks and effectively promote comfort and efficiency [24], and the score of humanization is particularly mentioned in the US IDEA review criteria. Accordingly, product structure could be a creative element focused in various contests.

Regarding to appearance shape, aesthetic review criteria are included in various creativity contests, requesting visual appeal and appropriate aesthetics, different or unexpected feelings about the product design, and the marvel effect and value to attract consumers. Such astonishing effect could merely attract the public by breaking through the appearance or function [25]. In this case, appearance shape is also a critical creative element in a contest.

What is more, production function is also emphasized, as production function is regarded as a critical element in product design. For instance, Liang [7] classified product design elements into two categories in the research on bicycle light design and found out "function" as the most important element in "major elements aiming at quality functional design". Chen [26] regarded three major elements of function, aesthetics, and economy, with the weights 0.33, 0.5, and 0.17, respectively, in lighting product design that "function" also showed the significance. Technology always comes from human nature. Improving current situations or increasing unexisting function in products would largely enhance the product value. As a result, product function is one of the creative elements emphasized in different contests.

The importance of modeling lies in aesthetics being able to make more attractive product shape, color, and style [27], [28]. From the table, modeling is better stressed in G-Mark than in other creativity contests, possibly because Japan G-Mark focuses more on visual creative element review, and such a trend is growing positively [29]. Especially, more than 22% visual innovation was contained in creative products in 2005, revealing the emphasis of G-Mark on visual perception. Modeling is a part of visual perception that G-Mark presents higher emphasis on modeling than other contests do.

Convenience appears in various groups, showing that the creative element is commonly included in the creative works of the groups. It is possibly because the factors of economic environment changes in societies, technology advance, and fierce business competition cause the increasing demands of product users for service convenience that the interests of product users in time and effort reduction have been emphasized in the academic circle [30]-[32]. The US IDEA review criteria also stress on the convenience for user benefits and duties. Consequently, convenience is covered in the creative works of various groups.

V. CONCLUSION AND LIMITATION

This study does not simply find out the 15 machinery creative elements, but further searches the most emphasized creative elements through the concluded four major international contests and three contest groups. Either the academic circle or the industry could select the most appropriate creative elements according to the categories for the invention in the future. Chen [33] considered that educational creativity could be cultivated. Although the problems of "can creativity be taught" and "what is creativity" are often encountered, the creative elements concluded in this study could, on one hand, assist teachers in developing creativity courses and allow learners who intend to start

businesses or in the RT department in the industry realizing the development trend of current machinery creativity and outlining creative products from the key creative elements and, on the other hand, offer creativity teachers with teaching points, reduce teachers' teaching load, and drive learners' creative thinking through such important creative elements.

The research results definitely point out the creative elements emphasized in four major international contests. However, as machinery is the major concern in this study, creative works in other fields are covered in the international contests. For example, IDEA (Industrial Design Excellence Award) covers not only industrial products but also package, software, exhibition design, and concept design in nine categories and 47 sub-categories. In this case, the differences in the creative elements of creative works in distinct fields for various international contests can be further discussed in the future. Furthermore, this study merely focuses on four major international contests; however, there are other international creativity contests largely recommended in domestic colleges and universities, such as Moscow International Salon of Industrial Property "Archimedes, Exhibition of Inventions Geneva-Palexpo, Concours Lepine, International Invention, Innovation & Technology Exhibition, Invention & New Product Exposition (INPEX), International Trade Fair "Ideas-Inventions-New Products" (IENA), and Seoul International Invention Fair (SIIF) (Intellectual Property Office, Ministry of Economic Affairs, 2015). When awarded works in above contests are included in the analysis of creative elements, sound and comprehensive creative elements for contests could be acquired for the reference of schools in different levels and the industry.

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