Application and Expansion of Rationalism in Industrial Design Curriculum Teaching

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Abstract: At present, rationalism is still used in design education. Through analyzing the characteristics, advantages and teaching cases of rationalism in the course design of industrial design, the paper discusses the principles and practice directions of rationalism in the field of industrial design teaching, and promotes the further development of industrial design teaching in the information age.

1. Introduction
With the development of China's economy, industrial design has received unprecedented attention. It has been written into the outline of the five-year plan for the development of the national economy three times, and the Outline of the 13th Five-Year Plan is even more explicit that it is necessary to "support the construction of the industrial design center." The establishment of the National Industrial Design and Research Institute has become an important driving force for the transformation from "made in China" to "Wisdom made in China". At the same time, China's design education has achieved rapid growth. According to the statistics of the Chinese Ministry of Education, there were more than 690 colleges and universities with more than 45,000 students in industrial design (including product design) and related majors in 2017, which reflects the huge demand for industrial design professionals. From 1980 to 2015, the official definition of industrial design continued to undergo major adjustments, and its connotation and extension continued to expand. How to strengthen the scientific and rational training in the process of industrial design teaching is also the requirement of the current era.

2. The Necessity of Rationalism to Industrial Design
Rationalism refers to a philosophical method based on the recognition that human reasoning can be used as a source of knowledge. It relies on logical reasoning and deductive argumentation to establish a vast system of knowledge. Rationalism in the teaching of industrial design refers to a set of methods based on logical reasoning and deductive argumentation in the teaching process.

Since the birth of industrial design, rationalism is indispensable. Mass production must depend on rationalism to achieve, which is the logical cause of industrial production, which is embodied in: maximization of benefits, division of labor and cooperation, repeated labor in batches, strict scientific management system, etc. The mode of mass production needs standardization, and the maximization of benefit also needs formula deduction and guarantee, these are the concrete embodiment of
rationalism. Therefore, rationalism, according to the logic of industrial production, not only exists widely in the practice of industrial design, but also inevitably appears in the teaching link of industrial design.

Nowadays, experience economy and service design are popular, which does not mean rationalism will exit, and it still has positive practical significance. The experience economy starts from the life and the situation, molds the consumer's sensory experience and the thought identity, seeks the new development space, these choices and evaluation need through the accurate data, the scientific analysis to provide the guarantee and the support. Nothing is more typical than big data's analysis to help segment users, find new market growth points and rationally guide the behavior and process of industrial design.

The definition of industrial design has been adjusted with the progress of the times. The definition of industrial design given by WDO in 2015 is defined as a strategic problem solving process, which consists of four aspects: product, system, service and experience, these cannot be separated from rationalism.

3. The Application of Rationalism in the Teaching of Industrial Design

3.1. Origin of Rationalism
The design of rationalism can be traced back to the period of the Deutscher Werkbund (DWB), it clearly points out that in the standardization and mass production, the aesthetic should pay more attention to the functional and scientific nature of the design, so the rationalism highlights its role. In the 1920s, the establishment of Bauhaus in Germany promoted the application of rationalism in the field of design education. Among them, the most important contribution was the basic course, which was first founded by Johannes Itten and was a compulsory course for all students. In the teaching of the basic course, Johannes Itten makes students discover the law of vision through the rational visual training. It is different from the uncertainty and irrational teaching mode of traditional art teaching, and inspires students' potential talent and imagination on the basis of rationalism. Walter Gropius, the founder of Bauhaus, also emphasizes the rationality and function, logic and technology of design, and this rational design education view and measures are gradually accepted in the world.

This scientific, rational design thought has a great influence. From the teaching example of the composition of the layout in figure 1, we can see that the visual graphic design at that time has already had a mathematical expression, emphasizing the objective analysis of form and color, and paying attention to the relationship between point, line and surface, so as to guide students understand the composition of two-dimensional space and 3D space. There are also classic buildings such as the Bauhaus school building and the Gropius residence. Moreover, Ludwig Mies van der Rohe also proposes the slogan "Less is more", which is equivalent to the idea of anti-abuse of annexes and over-decoration, and its Le Corbusier's “Mechanical aesthetics” and the Modulor can be said to be a symbol of rationalism, which is used in the design of the Marseilles apartment, the Chandigarh and the Ronchamp chapel. The Modulor of figure 2 exerts its proportional control effect to varying degrees, which can be described as the ultimate manifestation of rationalism in mathematical planning and designing, which is the concrete embodiment of rationalism in the teaching of early industrial design.
3.2. Application Examples of Rationalism in Industrial Design Teaching

At present, rationalism continues to play an important role in the teaching of industrial design, such as layout design, design expression, product design and so on. In the course of teaching, in addition to creating students' imagination from the perspective of sensibility, it is necessary to strengthen students' ability to master products from a rational perspective. For example, the “Layout Design” course is to arrange and combine the limited visual elements organically on the layout, and to present the rational thinking in a personalized way. In the teaching, it has its own design principles compared to other design courses. As shown in figure 3, the analysis of the overall layout design shows that in the design, we should pay attention to the design principles such as grid composition, primary and secondary distinction, classification and arrangement. There are also general basic forms for the layout design of text and graphics, such as the division between the upper and lower sides and the left and right sides, the repeated arrangement, frame arrangement, and so on. In this way, the designer is relatively easy to judge in the design process. If you do not consider any rules when designing a book or magazine, it will produce very messy results most of the time.

In the course teaching of “Product Form Design”, geometry is used to explore the laws of natural proportion, such as the golden section, perfect proportion and Fibonacci sequence, and so on. The quantitative mathematical proportion is the centralized reflection to the things with natural beauty, structure and law of change. In fact, there are strict mathematical rules in the modeling scale of many successful product designs. The positive cone pot designed by Aldo Rossi as shown in figure 4 is a cone formed by rotation of an equilateral triangle, which makes the whole shape easily decomposed into a 3×3 mesh system. The top of the kettle is just in the middle of the top three grids, the grid of the middle part comprises a spout and a handle, and the handle of the kettle can be regarded as an inverted right triangle, or a part of a square. This design makes the various basic geometries a part of its structure and also allows the bottom of the kettle to be in contact with the maximum area of the heat source. Strict mathematical relations make minimalist, generous, and observable products a classic existence.
In the course teaching of “Product Form Design”, the application of rationalism can be reflected by the training of product control line. In the product form design, the form of the curved surface is becoming more complex, and the control line is required to organically link each visual element, the whole and the part through a certain relationship. For example, when designing the electric blanket controller, we first add and design the necessary parts of the product, such as display screen, display lamp, icon, button, etc., which are added to the surface of the product. In the process of design, it is found that more piecemeal parts are easy to lead to the disorder of the whole, so the control line design is needed in the surface modeling of the product. The long blue C-type hidden line in the diagram is tangent to the ellipse of the outer frame of the screen, and the upper end is tangent to the ellipse of the outer frame of the screen. The lower end gradually vanishes, the slide button track design is also the continuation of the blanking line, at the same time the other buttons oblique arrangement is also parallel to the lower end of the C-type blanking line, so that all the elements are unified, the whole product is obvious more flexible and convenient. Through the use of these rational teaching links, students in the design process do not blindly rely on the feeling, they can be done to follow the evidence to make the design process more organized. At the same time, the results of the design guided by rationalism are more persuasive and acceptable.
It can be seen that rationalism has been reflected in Bauhaus teaching as long ago, although rationalism training has always existed in the current industrial design teaching, the phenomenon that sensibility is greater than reason is still common in students' work. In the work of students, it is necessary to strengthen rational analysis and training in the usual teaching to ensure that the results of design output are more scientific, reasonable and reliable.

4. The Expansion of Rationalism in the Teaching of Industrial Design

Although the teaching of industrial design has been carried out with different degrees of reform, there are still a lot of teaching contents and links in traditional art teaching methods, and the proportion of art sensual teaching contents is very high. The strengthening of rationalism in the field of industrial design teaching promotes the development of industrial design teaching, and infuses the characteristics of logic, clarity, connection and continuity into the teaching of industrial design, which makes the teaching of industrial design more abundant.

4.1. The Expansion Principle of Rationalism

Nowadays, the mainstream teaching system of domestic industrial design can be roughly divided into four basic modules: basic course, technical foundation, specialized course, expansion part. Every plate and every link should be fully involved in rationalism. We should be omni-directional, full-link expansion, each plate needs rationalism application. From the basic course, the students' rational thinking is cultivated, and the rational thinking of the technical foundation course is strengthened, so that the students can be applied in the professional courses, and then the students can use them well in the expansion course. Rationalism teaching should run through the whole course of industrial design teaching, so as to get better results. At the same time, we must also emphasize the expansion of the course link. For the design class subject, the emotional teaching link in the classroom is indispensable, but it is necessary to pay attention to the rational node control in the teaching process of the perceptual experience, so that students can feel the importance of rationalism in the classroom.

4.2. The Specific Expansion Direction and Thinking of Rationalism

Design education is carried out around the design process, and the design process, as shown in figure 6, requires three parts: design investigation, design conception and design and manufacture. In all aspects, the addition of rationalism can help students to design better.
The preliminary research of design plays an important role, which determines whether a product has the meaning of design. Random selection is likely to conflict with the existing product in the market. With the development of science and technology and the application of intelligent products, the current industrial design has changed from "thing" to "person", from "product itself" to "product service", which also shows that people pay more attention to the psychology, behavior, demand and so on of "person". The current design is built around the user's behavior, which can be trained through rationalism. For example, in the process of product design and research, POEMS observation method can be used for recording. POEMS observation method is based on five aspects: people, objects, environment, messages and service. The establishment of POEMS framework in the course of investigation can guide the observers to observe what to observe, how to record and consider the later collation and analysis. Accurate and clear product design research can provide effective support for subsequent designs.

After completion the preliminary research of the product, the use of rational thinking in the form design of the product can increase the possibility of the product. The design is carried out from the plan view, and the inference process from two-dimensional to three-dimensional requires the use of rational thinking. As shown in figure 7, the plane curves that have been designed are named 1, 2, and their corresponding three-dimensional shapes are analyzed. When curves 1, 2 are projection of faces, the shape is simply extruded; When 1 is a projection of a line, but there is no turning point in the outer profile, and 2 is a projection of a face, it is a relatively rounded shape. In addition to these two shapes, there are many possibilities, as shown in figure 8. This is the "orthographic projection inverse deductive method", a basic training technique for deducing three-dimensional shapes from plan view sketches. It is not only clear in train of thought, easy to grasp, but also able to perform more relevant shapes according to the different combinations of the source of the projection. It is very conducive to the deduction of the form, and can cultivate students' ability to evolve the plan view sketch into a three-dimensional form.

![Figure 6. Design process(self-painting).](image)

![Figure 7. Positive projection reverse deduction method example1.](image)
In the design process, it is necessary to fully consider the achievability of the molding process and functional structure of the manufacturing process, especially the function-oriented design. Therefore, it should pass certain in the teaching methods and training to guide students to form rational derivations in design. As shown in figure 9, the function analysis of the product first determines the main function, determines the sub-function under its premise, and then expands the existing sub-function according to the second-level function module. In this derivation process, the necessary functions can be identified, the redundant functions can be identified, and the level of functionality that needs to be improved is clearly identified, making it easier to discover innovations in the design. As shown in figure 10, the student's shoe washing machine product display, through the analysis of the overall structural rationality of the product, the problems found in the entire product use process, and targeted solutions. For example, in the fixing aspect of the shoe, the retractable rotating bracket is used to fix the shoe, and the length of the bracket can be controlled according to the system; in the water sprinkling, three-dimensional spray water flow technology is used, and the shoes on the bracket are sprayed on the inner cylinder. And there are other aspects that have been improved and innovated. Similar training, methods and skills can be added in curriculum teaching, so rationalism can be expanded better in teaching.

Figure 8. Positive projection reverse deduction method example2. (Source: Author: Chunmeng Weng, Xianfeng Ai title: "Product Form Design" Publisher: Peking University Press Publication date: 2016).

Figure 9. Product function design step diagram (self-painting).

Figure 10. Household washing machine display map / designer: Cong Zhou.

5. Conclusion
With the development of society, the concept and method of industrial design teaching should also be changed accordingly. In the current courses of industrial design, the concept of rationalism has
gradually weakened. However, as far as the practice of industrial development is concerned, there is an urgent need to strengthen and expand it. Rationalism in industrial design teaching not only helps to cultivate industrial designers who meet the needs of the industry, comprehensive design talents with professional literacy such as design integration ability, but also promotes the integration of design education and market to adapt to the development of the information age.

References
[1] Han Jun. (2009) Development of the Rationalism Design Conception. Journal of Jilin College of the Arts, (2): 29–30.
[2] Zhao Yujie. (2010) From Perceptual to Rational: an Analysis of Bauhaus' Design Thought. Artistic Exploration, 24: 54–55.
[3] Zhu Bing. (2011) On the New Rational Design Thought of Bauhaus. Art Criticism, (09):133-136.
[4] Cai Shunxing. (2013) Contradictory Analysis of Rationalism Layout Design. Journal of Nanjing Arts Institute(Fine Arts & Design), (5): 175–177.
[5] Cheng Ling. (2014) The Development and Pedagogical Implication of Western Rationalism. Contemporary Education and Culture, 6: 48–53.
[6] Yin Hu. (2014) Exploration of Interdisciplinary Comprehensive Industrial Design Teaching Mode. Journal of Graphics, 35: 459–463.
[7] Zhang Hechen, Xiang Zhongxia, Yang Junyu. (2017) Explorations on the Cultivation Mode of Industrial Design Talents from the Interdisciplinary Perspective. Design, (13): 85–87.
[8] Jiang Lin. (2017) Thoughts on the Current Situation and Strategy of Industrial Design Education in China. Education Modernization, (16): 106–107.
[9] Wu Lei. (2018) Teaching method and practice of industrial design specialty based on Emerging Engineering Education. Journal of Architectural Education in Institutions of Higher Learning, 27: 10–13.