

Research on Post Competency of Mechanical Design Engineer in Small and Medium-sized Manufacturing Enterprises under the Background of Industrial Upgrading

Zhongfu Bao^a, Lan Chen^b

Guangdong Mechanical & Electrical Polytechnic, Guangzhou, China

^abfjxie@163.com, ^bchenlan0502@126.com

Abstract. In view of the poor matching of mechanical design engineers in small and medium-sized enterprises under the background of industrial transformation and upgrading, this paper analyzes the requirements of this post for practitioners from the five dimensions of quality, motivation, knowledge, ability and psychology by constructing the competency model of this post. Through the investigation of small and medium-sized enterprises, 40 specific requirements indexes are determined, and the weight of each index is obtained by quantitative analysis with Likert rating scale analysis method, which can further distinguish the key indexes. Thus, it provides a basis for enterprises in talent recruitment, training and assessment, which can effectively improve the matching degree of talents and posts, and inject vitality into the development of small and medium-sized enterprises.

Keywords: Small and Medium-sized Enterprises; Mechanical Design Engineer; Competency.

1. Introduction

Manufacturing industry is in the stage of transformation and upgrading to advanced manufacturing industry in China. Compared with traditional manufacturing industry, advanced manufacturing industry specifically refers to the development of advanced manufacturing technology that can realize automation, intelligence, flexibility and ecological production on the basis of integrating modern science and technology, management technology and other new achievements, and the comprehensive application of this technology to the whole process of product design, production and manufacturing, online detection, marketing service and management, The general name of manufacturing industry that has achieved good economic benefits and market effects.

The advanced manufacturing industry has a great demand for all kinds of special automation machinery and production lines. This kind of automatic equipment is usually customized for the automatic production process of specific products, and the degree of non-standard is very high. From the perspective of the detailed industrial chain of automation equipment design and manufacturing, large enterprises are at the front of the industrial chain, mainly providing various standardized components, such as various servo motors, ball screws, linear guide rails, industrial mechanical arms, etc. small and medium-sized enterprises are at the middle and back of the industrial chain, mainly carrying out customized design, manufacturing, assembly and commissioning for the personalized production needs of customers.

Mechanical design engineer is an important technical post in small and medium-sized enterprises. They mainly undertake the customized design of automation equipment. From the perspective of technical process, this work connects the functional requirements analysis of customers and the processing and manufacturing of specific equipment products. It can be seen that small and medium-sized enterprises need more professional knowledge in project negotiation and management. In order to deeply understand the job requirements of Mechanical Design Engineer in small and medium-sized manufacturing enterprises, so as to facilitate the selection and training of talents matching the post, carry out research based on competency theory, build a five-dimensional competency model, and carry out quantitative research on various competency factors and weights of the post.

2. Overview of competency theory

2.1 Proposal of competence

It is generally believed that competency was first proposed by Robert white, who proposed that the competency of an employee can be measured by intellectual factors. MC Clelland proposed further improvements. He believes that competence is not only determined by intellectual factors, but also the knowledge, skills, personality traits and performance related abilities of excellent and ordinary employees [1]. Chongming Wang first introduced the concept of competence in China. He defined competence as the combination of knowledge, skills, abilities, values, personality, motivation and other characteristics [2]. This view has been widely recognized. Based on this view, some scholars have studied the victory of manufacturing employees and vocational college teachers [3,4]. This paper uses such an analysis dimension to carry out the research.

2.2 Competency model

Competency model is a more intuitive embodiment of the connotation of competency. At present, there are two common ones, namely "iceberg" and "onion", as shown in Figure 1. They reflect the status and role of different competency factors.

The iceberg model constructs competence as an iceberg floating in the water, which can be divided into visible parts on the water surface and invisible parts under the water surface, representing the explicit and implicit elements of competence respectively. Explicit elements include knowledge and skills; Implicit elements include motivation, personal characteristics, self-concept and so on.

The onion model is a structure that builds competence into layers, the core of which is motivation, and then expands outward in turn into personality, self-image and values, social roles, attitudes, knowledge and skills. The more to the outer layer, the easier it is to cultivate and evaluate; The more inward, the more difficult it is to evaluate and cultivate.

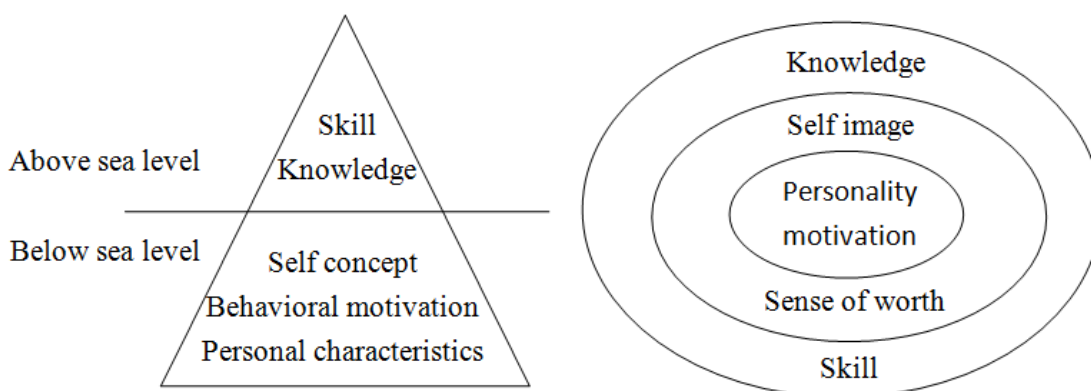


Fig.1 Iceberg model and onion model

3. Construction of competency model

3.1 Research design

Firstly, by selecting several advanced manufacturing small and medium-sized enterprises as the survey and interview objects, the human resources director and technical director of the enterprise are invited to carry out interviews. Through the behavioral event interview method and questionnaire survey method, we can understand the work content, thought and quality of engineers in advanced manufacturing small and medium-sized enterprises, and then analyze and sort out the interview data to preliminarily determine the competency characteristic indicators.

Secondly, experts from industry enterprises are invited to carry out analysis and discussion, revise and improve the preliminarily determined competency indicators, and finally build them into five dimensions, a total of 40 specific indicators.

Finally, the Likert rating scale analysis method is used to evaluate each index factor according to important, relatively important, general, less important and unimportant, and calculate the weight.

3.2 Competency index analysis

The competency of mechanical design engineers in small and medium-sized enterprises is mainly constructed from five dimensions: quality, motivation, knowledge, ability and psychology.

3.2.1 Quality dimension index

Small and medium-sized manufacturing enterprises cluster, and there is a fierce competitive relationship between them. Mechanical design engineers in small and medium-sized enterprises usually master the core technology of enterprises, and enterprises attach great importance to their professional loyalty and integrity. At the same time, the development of automation equipment is a challenging work, which not only needs to communicate effectively with customers, but also overcome various problems in the development process. To sum up, eight factors are determined in the quality dimension: loyal to the enterprise, enthusiastic and proactive, honest and trustworthy, hard-working, dare to work hard, serious and responsible, optimistic and flexible.

3.2.2 Motivation dimension index

Mechanical design engineers in small and medium-sized enterprises need strong internal drive to be competent. This internal drive can come from the pursuit of their own interests and sense of achievement, or the desire to realize their own social value and obtain recognition. To sum up, there are five factors in the dimension of motivation: a sense of achievement in career development, obtaining good economic income, obtaining praise or social reputation, conforming to social development and undertaking social responsibility.

3.2.3 Knowledge dimension index

The manufacturing industry has been upgraded rapidly, and there is a large demand for automation equipment in all walks of life. Mechanical design engineers in small and medium-sized enterprises are engaged in customized design of automation equipment, which covers multi-disciplinary knowledge and technology. Through the analysis of the typical work of the post, it can be analyzed and determined that there are 13 factors in the knowledge dimension: engineering calculation, reading and drawing of drawings, design of mechanical transmission system, design of mechanical parts, preparation of process procedures, quality inspection and management, design and commissioning of pneumatic transmission system, design of special fixture for automation, design of special machinery for automation and production line scheme, selection design of automatic components Automatic working device design, automatic special machinery and production line system integration, digital sample mechanism construction and simulation optimization.

3.2.4 Capability dimension indicators

Mechanical design engineers in small and medium-sized enterprises belong to compound technical and skilled talents. Through refining their work task technology, eight factors can be determined in the ability dimension: self-learning ability, communication and coordination ability, team leadership ability, research report writing ability, hands-on operation ability, achievement transformation ability, information collection and analysis ability and innovation ability.

3.2.5 Psychological dimension index

The majority of small and medium-sized enterprises are highly sensitive to the market, with high work efficiency, fast work pace and large amount of information. To adapt to such a working environment, they need better psychological quality. Therefore, in terms of psychological dimension, it is mainly determined that there are six factors: adaptability to the environment, pressure resistance, self-motivation, sense of personal achievement, willingness to accept challenges and strong interest in new things.

3.3 Construction of competency model

Based on the indicators analyzed above, the Likert rating scale analysis method is adopted, and the human resources directors or technical directors of 98 enterprises participate in the scoring. After statistics, the competency model can be obtained, as shown in Table 1.

Table 1. Competency model

Indicator dimension	Factor item	Weighted score	Weight
Quality	X ₁ : Loyal	476	2.69%
	X ₂ : Enthusiastic and proactive	456	2.58%
	X ₃ : Honesty and trustworthiness	462	2.61%
	X ₄ : Endure hardships and be capable of hard work	468	2.65%
	X ₅ : Dare to struggle	456	2.58%
	X ₆ : Serious and responsible	484	2.74%
	X ₇ : Optimistic upward	440	2.49%
	X ₈ : Flexible	422	2.39%
Motivation	X ₉ : Career development and sense of achievement	460	2.60%
	X ₁₀ : Obtain better economic income	440	2.49%
	X ₁₁ : Gain approval or social reputation	424	2.40%
	X ₁₂ : Conform to social development	426	2.41%
	X ₁₃ : Assume social responsibility	414	2.34%
Knowledge	X ₁₄ : Engineering calculation	460	2.60%
	X ₁₅ : Reading and drawing of drawings	484	2.74%
	X ₁₆ : Mechanical transmission system design	464	2.62%
	X ₁₇ : Mechanical parts design	458	2.59%
	X ₁₈ : Preparation of process specification	440	2.49%
	X ₁₉ : Quality inspection and management	414	2.34%
	X ₂₀ : Design and commissioning of pneumatic system	426	2.41%
	X ₂₁ : Design of special fixture for automation	404	2.29%
	X ₂₂ : Scheme design of automation special machinery	406	2.30%
	X ₂₃ : Selection and design of automation components	440	2.49%
Ability	X ₂₄ : Design of automatic working device	430	2.43%
	X ₂₅ : Integrated design of automatic production line system	428	2.42%
	X ₂₆ : Digital simulation and optimization design	426	2.41%
	X ₂₇ : Self learning ability	462	2.61%
	X ₂₈ : Communication and coordination	484	2.74%
	X ₂₉ : Team leadership	414	2.34%
	X ₃₀ : Research Report Writing Ability	414	2.34%
	X ₃₁ : Hands on operation ability	460	2.60%
	X ₃₂ : Achievement transformation ability	440	2.49%
	X ₃₃ : Information collection and analysis ability	446	2.52%
Psychology	X ₃₄ : Innovation ability	442	2.50%
	X ₃₅ : Adapt to the environment	402	2.27%
	X ₃₆ : Compressive capacity	452	2.56%
	X ₃₇ : Self motivation	466	2.64%
	X ₃₈ : Willing to accept challenges	464	2.62%
	X ₃₉ : Personal sense of gain	444	2.51%
	X ₄₀ : Have a strong interest in new things	382	2.16%

4. Analysis of key competency characteristics

The weight of each index fluctuates around 2.5%, without much difference, which indicates that this survey is very sufficient. Finally, the factor indicators extracted and sorted out have been recognized by enterprise directors and experts.

Although there is little difference in the weight of various factors and indicators, it also reflects the different attention of enterprises to various indicators. In the dimension of motivation, loyalty and responsibility are the most important indicators for enterprises. In the dimension of motivation, career achievement is considered to be the most important career driving force. In the knowledge dimension, engineering calculation and mechanical drawing are considered to be the most important. These two belong to the basic knowledge of science and engineering, representing the ability of logical thinking and spatial imagination. In the ability dimension, self-learning ability and communication and coordination ability are considered to be the most important indicators, which shows that in the era of knowledge explosion, having self-learning ability can maintain career development. At the same time, customized design facing customer needs very good communication ability. In the psychological dimension, self-motivation and willingness to accept challenges are considered to be the most important indicators, because small and medium-sized enterprises face greater survival pressure and higher requirements for the psychological quality of engineers.

5. Summary

Based on the construction of the post competency model of Mechanical Design Engineer in small and medium-sized enterprises, we can have a clearer understanding of the specific requirements and indicators of this post for practitioners. Through the weight obtained by quantitative analysis, we can further distinguish the key indicators. Thus, it provides a basis for enterprises in talent recruitment, training and assessment, and can effectively improve the matching degree of talents and posts.

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- (4). Guangzhou philosophy and Social Sciences "13th five-year plan" project (No.2020GZGJ223).

References

- [1] MCCLELLAND DC. Testing for competency rather than for "Intelligence" Am Psychol. Vol.28(1973) No.1, p.1-14.
- [2] Wang Chongming. Management psychology. People's Education Press, 2001, p. 231-236.
- [3] Xu Lan. Research on Intelligent Logistics Personnel Training Mode Based on Competency Characteristics under the Background of Industry 4.0. Research on Vocational Education. Vol.5(2021) No.5, p.56-62.
- [4] Peng feixia. Competency of Vocational Education Teachers under 1 + X certificate system: structural model and optimization path. Chinese Vocational and Technical Education. Vol.18(2020) No.6, p.12-18.