Design and analysis of application engineering talent cultivation based on AHP and QFD

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Abstract. Some issues in cultivating practice-oriented talents in higher education of the newly established local universities are addressed. Combined with the school-running mode, the orientation and the social requirement, the advanced manufacturing industry oriented application engineering talent cultivation mode was analyzed. The application engineering talent cultivation program is studied and established based on AHP and QFD. AHP can be used to confirm weight of voices of the customer in QFD. The designed cultivation program will satisfy stakeholder requirements and will improve the quality of graduates. The cultivation mode is practiced in SSPU and will spread to other specialties in future.

Introduction

With the developing of the IE4.0 and higher application talent cultivation, practice-oriented talents in engineering specialty is more and more important. At present, application engineering talent cultivation mode faced with several problem, including orientation, knowledge updating, practice ability inadequate, market adaptability and so on.

Students faced with fierce market competition, when they graduated. The figure 1 shows the competition factors based on Michael Porter's Five Forces Model. application engineering talents have some certain bargaining power as suppliers. But there are lots of new graduates and experienced relative persons enter the market. The current enterprise still hold the conservative views to relevant posts. So, application engineering talent cultivation competition improvement is very important, and the cultivation program is the basis of the talent cultivation.
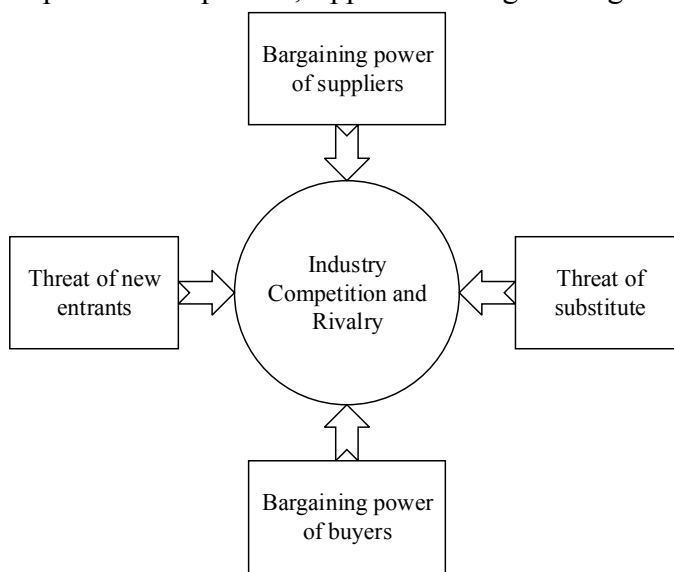

Fig.1 Five Forces Model

QFD and AHP

Quality function deployment(QFD) is a production development method, which can translate the customer or market requirements into design targets. The main advantage of the QFD is when it analyzed and constructed the different layer elements, it can focus on the customer demand, key design and identify conflicts, shorten product development cycle and reduce the service cost. But using the traditional discrete scale 'strong, middle or weak' method to determine the weight of the customer needs is not enough, which can lead to the wrong analysis result.

Analytic hierarchy process(AHP) is a systematic decision making method which collates the relevant data and decision making into target layer, criteria layer, program level layer, etc. The main

advantage of the method lies in using the quantitative data as little as possible, it can make the decision quickly and practically for multi-objective. But the AHP method can only make decisions in the existing schemes, cannot provide the new solution. If the selected elements is not reasonable, or the relationship between elements is not correct, it will lower the quality of the results of the AHP, and even cause the decision failure. In addition the commencement of the eigenvalue and eigenvector of the accurate calculation methods is more complex.

So, AHP and QFD methods are highly complementary in advantages and disadvantages. If using the complementary to design the talent cultivation program, it can exert great effects. Some studies have proposed the integration of AHP with QFD, where AHP's role would be to identify the priorities of the customer requirements and QFD would improve the decision making[1-4].

Fig2 shows that it can identify the stakeholder's requirements, introduce competitive advantages and determine the weight of competitive advantages using AHP method, then using the result as the part of the QFD input to select and determine the important lean attributes on competitive advantages using QFD method. Based on QFD and AHP method, the cultivation program can be design and evaluation.
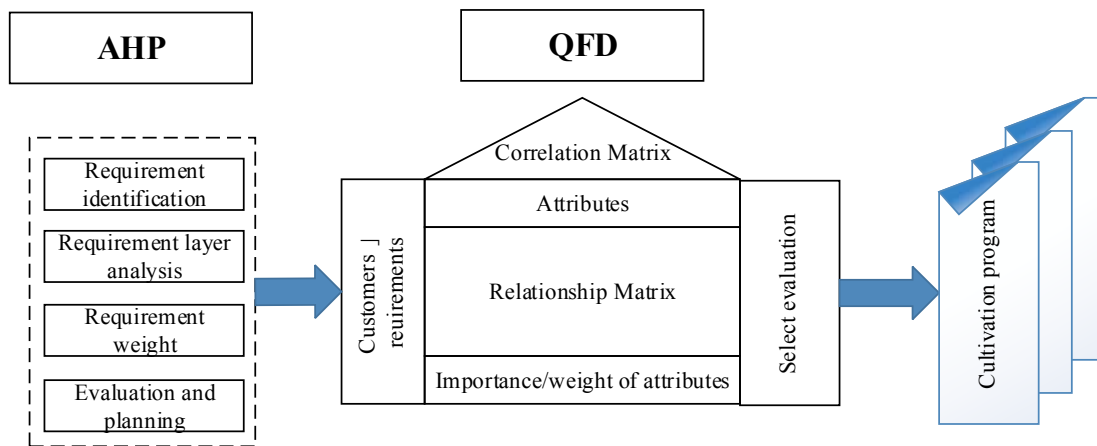

Fig.2 The flow chart of cultivation program design based on AHP and QFD

AHP model

Identifying the customers' requirements (CRs) in higher education is very difficult. The students, parents, faculty, employers, government and public are all the customers but have different requirement. How to design a cultivation program, which can make students apply knowledge and skills from college to worksite and have a sustainable competitive advantage as well, is a very important issue. Based on earlier studies, investigation and dislocation competition analysis, the customers' requirements and the competitive advantages are determined.

IE specialty is one of the key supporting specialties in advanced manufacturing industry. IE exerts more and more impacts on quality guarantee, productivity increasing, cost reduction, economic benefit promotion and enterprise whole competitiveness strengthening etc. IE is the bridge and link of the advanced manufacturing technology and advance management mode. The applied innovative talent cultivation of the IE specialty in applied undergraduate colleges and universities is the important approach to improve the employability from root to branch. According to our university talent cultivation feature, collect the information from the students, enterprises and some specialists, most our IE graduates were employed by manufacturing enterprise, and mainly responsible for production system optimization, quality management and flow analysis etc.

Hierarchy construction, priority analysis and consistency verification are the main three steps to establish the AHP model[5]. The first step of applying AHP in weighting the importance of CRs is to structure CRs into different hierarchy layers. Then based on the competitive advantages analysis, the

weight of competitive advantages can be determined with AHP. Fig.3 is the IE requirement hierarchical model of IE specialty talent cultivation program.
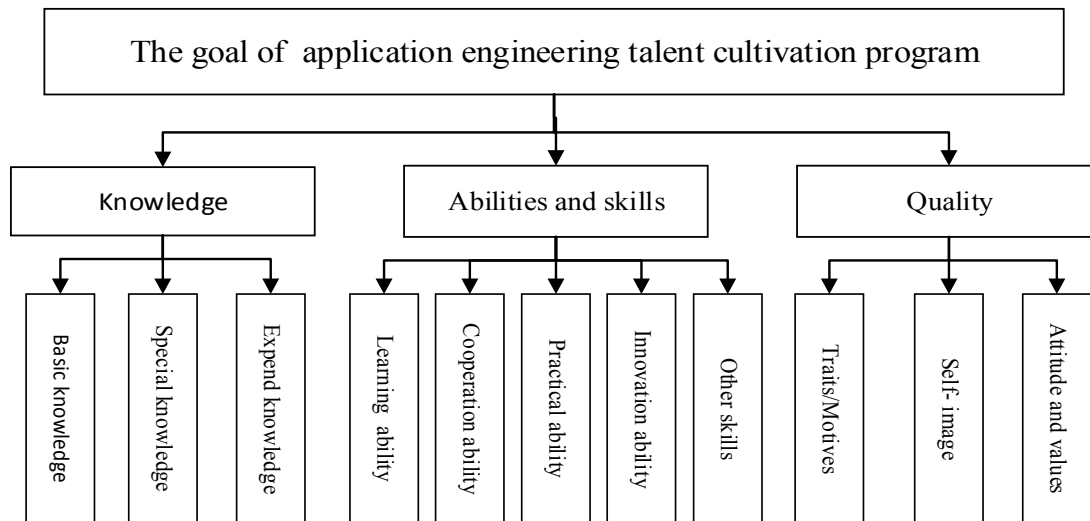
Fig.3 AHP model for the requirements of the IE talent cultivation

According to the requirements hierarchy of the knowledge, abilities, skills and quality of application engineering talent, using the T.L.Saaty's 1-9 scale method of evaluation of the indicators in different pair wise comparison, the structure comparison matrix A can be established.

$$A = \begin{bmatrix} a_{11} & \cdots & a_{1n} \\ \vdots & \ddots & \vdots \\ a_{n1} & \cdots & a_{nn} \end{bmatrix}$$

(1)

Solving matrix to determine the characteristics of the root, find the largest eigenvalue λ_{max} and its corresponding feature vector $W=(w_1,w_2,\ldots, w_n)^T$, $\sum_{i=1}^{n} w_i=1$. W is the vector of the importance weighting determined by the AHP model.

$A \times W = \lambda_{max} \times W$ (2)

Because small changes in a_{ij} imply a small change in λ_{max}, the deviation of the latter from n is a measure of consistency. The consistency ratio is defined as

$C.I.=(\lambda_{max} -n)/(n-1)$ and $C.R.=C.I./R.I.$ (3)

In which *R.I.* are test values of average consistency, where *R.I.*=0, 0, 0.52, 0.89, 1.12, 1.26, 1.36, 1.41, 1.46, 1.49, 1.52, 1.54, 1.56, 1.58 and 1.59 for the matrix order *n*=1-15. If *C.R.*≤0.1, the consistency verification is acceptable.

QFD model

application engineering talent cultivation program in our university mainly concerns the application and innovation cultivation based on engineering area knowledge. Talent cultivation system is reflected by the curriculum system and cultivation process. How to design the curriculum system, QFD is a very effective method[6]. The core of the QFD is the construction of the house of the quality. It needs to complete several steps, they are, specialty abilities requirements and importance weight computation, core courses determined, the relationship between abilities and courses, the relative matrix of courses, evaluation matrix and quality design etc. The ability and courses evaluated correlations of the relational matrix are expressed by symbols ●, ○ **and Δ** indicate strong correlation, moderate correlation and weak correlation respectively and can be presented as 5, 3 and 1 to ensure

that their differences can be effectively distinguished. The Fig.4 is the complete matrix example about the IE specialty, others specialties can be drawn at the same way.

Courses (C) / Abilities (A)	Public	Professional basic	Professional	Practice	Weight(W)

(Full QFD relationship matrix with course columns grouped as Public, Professional basic, Professional, and Practice; ability rows grouped as Quality, Knowledge, and Abilities and skills. Relationship symbols ●, ○, △ indicate degrees of relationship.)

Quality:
- Self-image — 0.04
- Health — 0.04
- Morals and cultivation — 0.04
- Culture — 0.02
- Traist/motives — 0.04
- attitude & value — 0.03

Knowledge:
- Basic — 0.03
- Professional — 0.03
- Expond — 0.02
- Learning — 0.04
- Application — 0.05

Abilities and skills (Basic):
- Logical Analysis — 0.03
- Expression — 0.03
- Computer application — 0.03

Enginery:
- Basic cognition — 0.03
- Professional skill — 0.04
- Application — 0.05

Mangement:
- Basic — 0.03
- Production & quality — 0.05
- Project management — 0.04
- Financial analysis — 0.02

Practise and Innovation:
- Investigation and — 0.05
- Operation — 0.05
- Analysis and sovling — 0.05
- Plann and integration — 0.05
- Innovation — 0.05

Course column headers (left to right):

Public: Ideological and political, Sports, Languages, Mathematics, Computer, Exponds, Probability and Statistics

Professional basic: Mordern engineering drawing, Engineering Mechanics, Mechanical principle, Mechanical design, Automatic control principle, mechanic manufacturing basis, Hydraulic and pneumatic transmission, Electrician and electronics, Operations research, Specialty English, Production management, CAD, Algorithmic language and database, Engineering economics

Professional: Quality management, Logistics and supply chain, Electromechanical control, Management, Product data management, Mangement information system, Production system mod.&sim., Product plan and control, IE introduction, AMT, Decision optimization, System engineering, Mordern design, Financial management, Enterprise strategy, Marketing, HR management, Project management

Practice: Military training, Metalworking practice, Specialized education, Machinery course design, Computer course design, Electric course design, Product management course design, Quality course design, Professional practice, Internships, Professional competitions, Graduation project

Fig.4 The QFD analysis example of IE cultivation program

For example, according to the ability requirement analysis of IE cultivation program, combine the investigation data, the relationships of abilities and courses are drawn, that is the relational matrix R_{ij} as shown in legend. Using above analysis of AHP, the W_i can be computed. The H_j is the courses improvement importance, which was determined by multiplying the corresponding value in the matrix R_{ij} and the degree of importance of abilities A_i. That is

$$H_j = \sum_{i=R}^{m} W_i R_{ij} \qquad j = 1, 2, \cdots, m \tag{4}$$

Then the courses were ranked according to their degree of importance based on their product values. So, the most important courses can be set as the core course for the cultivation program. At present, our IE specialty core courses are operation research, production planning and management, quality management, production system modeling and simulation, etc.

Based on the relationship of the courses, the credit, curriculum planning can be adjusted and the corresponding practice planning can be established. So with the change of CRs and the development of the knowledge and skills, the IE talent cultivation program and course system can be revised and improved.

Summary

AHP and QFD are applied to talent cultivation program design for satisfying the CRs. Major CRs and competitiveness of application engineering area talent cultivation are identified by Five Forces Model. The AHP is proposed to weigh the CRs for talent cultivation program and course system design using QFD, which can provide the more accurate priority ranking of the CRs. The investigation, identification and analysis of importance of the CRs based on different talent cultivation goal is very important, because it can keep up the talent cultivation program with times, reflect education features and improve the cultivation quality.

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