

# ASSESSMENT AND ANALYSIS OF ENGINEERING PRACTICAL ABILITIES LEARNING OUTCOMES OF UNDERGRADUATES THROUGH UNIVERSITY-ENTERPRISE COOPERATION

BAO Nengsheng, LU Xiaohua

College of Engineering, Shantou University, China

CHEN Yueyun

Human Resources Department, Esquel Group, Hongkong, China

## ABSTRACT

Through CDIO syllabus, CDIO initiative emphasizes the training of students' abilities. In 2010, the Chinese Ministry of Education started the Excellent Engineer Education Plan which also emphasized the abilities training, especially the engineering practical ability. The Plan proposes the "Three+One" training mode for its implementation in both colleges and enterprises. The "Three+One" stands for three-year theory-majored study in colleges and one-year practice in enterprises. However, both CDIO and the Plan are facing a critical issue: how to evaluate students' learning outcomes, especially engineering practical ability training outcomes. After more than one year's joint implementation on the undergraduate education in engineering practice, Shantou University and Esquel Group went into a new phase of cooperation to address this issue. Combined with the technology and management positions assessment in enterprise, two units jointly built the engineering practice competency model for undergraduates and designed an assessment method with a process and its operating instruction for engineering undergraduates, which is based on on-site team projects and face to face communication. The method was applied on 13 Mechatronic engineering undergraduate students of Shantou University for the first time. These students joined the Plan and studied in two enterprises by following the Plan. The undergraduates' assessment result was also applied on the appointment of engineering technical positions in enterprises.

## KEYWORDS

Engineering Student Competency Model, Engineering Practice, Abilities Assessment, Undergraduate student, Intended Learning Outcomes, University-Enterprise Cooperation

## INTRODUCTION

Higher engineering education should be based on comprehensive development, social needs and international background, which develops the graduates with all-round competencies explicit and implicit in developing a successful career (Chinese Academy of Engineering Education Committee, 2007). It means that graduates not only acquire the working skills, but also learn to live and survive. Therefore, one priority to higher engineering education is to explore different approaches to improve education quality, student competency model and investigation of problems at home and abroad, which also intends to improve students to exercise self-management, self-service and core competencies in interpersonal communication.

How to design and implement an effective approach for developing capabilities become a critical part of higher education. Decades of experience on engineering education in China has shown that University-Enterprise Cooperation can be one effective approach for developing .... capabilities. In June 2010, the Chinese Ministry of Education comes up the Excellent Engineer Education Plan which encourage the “Three+One” training mode joint with both colleges and enterprises. “Three+One” stands for *Three* years’ knowledge-majored study in colleges and *One* year’s product design-oriented practice in enterprises. College of Engineering, Shantou University, is a part of the Plan.

Shantou University (STU), founded in 1981, is a comprehensive university jointly supported by the Ministry of Education, the Guangdong Provincial Government and the Li Ka Shing Foundation. It is the only public university in the world that receives long-term funding from the Li Ka Shing Foundation. The University campus is located in the northwestern part of Shantou, a seaside city, Guangdong Province, China. The University consists of 8 colleges and schools, namely, College of Liberal Arts, College of Sciences, College of Engineering, Medical College, Law School, Business School, Cheung Kong School of Art and Design, and Cheung Kong School of Journalism and Communication. It enrolls qualified students from all over the country. The Mechanical Engineering Program in STU took part in the Excellent Engineer Education Plan in 2010 and has started the university-enterprise education, cooperated with many international companies since then. The cooperation was implemented especially on that, the undergraduates spent the whole fourth year in enterprises on receiving engineering practice training, and carrying out and completing the graduation design of practical subjects based on engineering requirements of the enterprise.

Founded in 1978 and Headquartered in Hong Kong, Esquel Group is one of the world’s leading producers of premium cotton shirts. With production facilities in China, Malaysia, Mauritius, Sri Lanka and Vietnam, and a network of branch offices servicing key markets worldwide, the Group is one of the most dynamic and progressive global-scale textile and apparel manufacturers with a vertically-integrated supply chain that straddles from cotton to retailing. Esquel employs a 58,000 multinational workforce. Esquel manufactures over 100 million pieces of garments annually for leading brands including Ralph Lauren, Tommy Hilfiger and Nike. Long an advocate in innovation, environmental protection and corporate social responsibility, Esquel aspires to make a difference in the textile and apparel industry and contribute to the well-being of a wider community.

The Mechanical Engineering Program in STU focuses on educating technical and management talents with good thinking and practical ability, teamwork and communication skills, and developing their interest in intelligent equipment, production manufacturing lines, industrial automation and other fields of mechanical design and electrical design automation. The Esquel Group, which was pursuing the automation and intelligence of clothing manufacturing, started cooperation with Shantou University in 2013. The joint education of STU-Esquel on the undergraduate students in Mechanical Engineering has been developed since then.

Firstly, by a survey of stakeholders of teachers, students and employers through interview, questionnaire and statistical analysis, STU and Esquel Group jointly built the engineering practice competency model for undergraduate students. And then based on the model, comprehensive assessment methods are given with examples (e.g., some questions and special observation points from undergraduate students). Accordingly, an evaluation process and model are developed and expected to make an effective assessment on

students' ability during their enterprise education. A special instance of undergraduate assessment results from Esquel Group and STU are shown at the end of this paper.

## COMPETENCY MODEL OF ENGINEERING UNDERGRADUATE STUDENTS

Competency model defines the underlying sets of skills, knowledge, personal characteristics and abilities that needed to perform in a role and helps achieve the organization's goals (Anne F. Marrelli, 2005) (Mark A Albanese, 2008). The competencies and corresponding level assessment are defined and described in a model (Bradley, 2008). Competency model enables the identification, evaluation and development of the behaviors in individual employees. It helps build a strategic HR foundation for subsequent staffing, development, succession planning, and performance management. It has many types like position competency models for technical, managerial and marketing positions (Glenn M, 2005).

### *Dimensional Representation of Competency Model*

Based on the above competency model and construction method, College of Engineering of STU and cooperative enterprises, construct undergraduate competency model suitable for our college orientation and professional cultivation objectives. The model is composed of two parts:

The core competency model of operational excellence department, are described in detail as shown in Table 1, including *Four Dimensional Representations*, such as, mental health and behavior, teamwork, leadership, execution.

The competency model related to the working position, are described in detail as shown in Table 2, including *Four Dimensional Representations*, including leadership, critical thinking, effective problem solving, innovation and application, communication and interpersonal communication, active learning and independent thinking.

Table 1. The dimensional representation description of core competency model for operational excellence department

Representations	Descriptions
Features	Low cost, high quality products and service to provide value for customers
Core abilities	Team Cooperation
Quality of staff	<ul style="list-style-type: none"> <li>•Mental health and behavior</li> <li>•Teamwork</li> <li>•Leadership</li> <li>•Execution</li> </ul>
<b>1. Mental health and behavior</b>	
Definition	Health status; Oneself and interpersonal relationship; Life adaptation and psychological adjustment; Ethical behavior and individual morality
Key concepts	Pleasant personality, emotional stability, Optimistic, interpersonal harmony, good conduct

Main behaviors	<ul style="list-style-type: none"> <li>•Good health and physical strength;</li> <li>•Pleasant personality, emotional stability, optimistic, interpersonal harmony ;</li> <li>•Own a strong ability to adapt to life and psychological adjustment ability, be able to correctly deal with difficulties and setbacks</li> <li>•Keep the faith, resolute in the idea and ability;</li> <li>• Be able to handle interpersonal relationships and moral behavior in the interpersonal communication, and personal moral cultivation</li> </ul>
<b>2. Teamwork</b>	
Definition	Clear team goals, lead the team, pay attention to internal team and team's relationship with other institutions or organizations, to achieve common goals
Key concepts	Fully inclusive and equitable, act with united strength, external cooperation, to establish cooperative network, respect for others
Main behaviors	<ul style="list-style-type: none"> <li>•Clarify the roles and tasks of team members, take personal responsibility in the team;</li> <li>•Play fair, concerned about team members and coordinate relationships, provide timely support and assistance, encourage team towards common goals;</li> <li>•Coordinate the relationship between the team and the other team, clarify the cooperation mechanism among teams;</li> </ul>
<b>3. Execution force</b>	
Definition	In strict accordance with the definition of business process, driving the operation of a business process instance
Key concepts	Specification, process control, pay attention to the process
Main behaviors	<ul style="list-style-type: none"> <li>•Pay attention to the regulations, to do things organized</li> <li>•implement and follow up tasks according to regulations</li> <li>•Consider repeatability and sustainability, focus on every step in the process</li> <li>•Take the initiative to find and willing to accept new ideas, experience and ways of doing things, improve the current process and system, etc</li> </ul>
<b>4. Leadership</b>	
Definition	Drive oneself and team members to achieve stated goals energetically in as short a time period as possible, .
Key concepts	Set goals, focus on the target deadline, overcome obstacles, reach the goal
Main behaviors	<ul style="list-style-type: none"> <li>• Attention to the deadline of reaching the goal, driving the team put in more effort, to accomplish the goal in the shortest possible time;</li> <li>• To put the time and effort required for the work, have the courage to try, try to overcome obstacles to complete the task;</li> <li>• Maintain focus, tough, dedication; mobilize the required resources, to ensure to reach the objective.</li> <li>•The final results for action guiding, attach importance to practical action</li> <li>•Not satisfied with the status quo, refine on request</li> </ul>

Table 2. The dimensional representation description of core competency model related to the working position

<b>Representations</b>	<b>Descriptions</b>
Features	Low cost, high quality products and service to provide value for customers
Core abilities	Critical thinking
Quality of staff	<ul style="list-style-type: none"> <li>•Critical thinking and effective problem solving</li> <li>•Innovation and Application</li> <li>•Active learning and independent thinking</li> <li>•Communication and interpersonal communication</li> <li>•Active learning and independent thinking</li> </ul>
<b>5. Critical thinking and effective problem solving</b>	
Definition	Doubt routine, the innovation idea, change; Timely and effectively solve the difficult problem; Follow up until the obstacle is ruled out.
Key concepts	Recognize problems, feasibility analysis, determine the solution plan, carry out and follow up project
Main behaviors	<ul style="list-style-type: none"> <li>•To grasp the essentials, have genius for discrimination, based on rigorous inference, witty aura, daily clear thinking agility.</li> <li>•In the face of difficulties, timely put forward or to perform a feasible solution;</li> <li>•Provide the resources to solve the problem, or offered to resource requirements and follow up to ensure that resources are in place;</li> <li>•Implement and track solution, ensure the effective solution to the problem</li> </ul>
<b>6. Innovation and Application</b>	
Definition	Have the ability to think from multiple angles, facing the challenge to come up with a new and effective solution.
Key concepts	Overall innovation, good at invention and creation, continuous improvement, good at learning
Main behaviors	<ul style="list-style-type: none"> <li>• Not satisfied with the commonly accepted views, look for new opportunities for improvement</li> <li>• Create a better solution to meet customers' needs and expectations</li> <li>•Looking for internal and external resources, using the views and ideas that have been confirmed, create new solutions</li> </ul>
<b>7. Communication and interpersonal communication</b>	
Definition	Enthusiasm, clearly, correctly listening and communication, to create an atmosphere of open communication
Key concepts	Listening, expression, conflict processing
Main behaviors	<ul style="list-style-type: none"> <li>• Clearly, clarify, logically express personal thoughts and opinions; emphasis;</li> <li>• Using the appropriate speed, volume, language, body language, etc, performing proper enthusiasm ;</li> <li>• Pay attention to others' message; correctly interpret the information and respond appropriately</li> </ul>
<b>8. Active learning and independent thinking</b>	

Definition	Find out their own strengths and weaknesses, maintain their own advantages, improve the shortcomings; to determine their own development needs, and change the environment to improve individual and organizational performance
Key concepts	Predict the gap, continuous learning, and apply it in the work
Main behaviors	<ul style="list-style-type: none"> <li>• According to the needs of the work, actively participate in learning new knowledge and skills ;</li> <li>• Actively learning relevant knowledge of different disciplines under different cultural backgrounds and new ideas and new knowledge generated from the intersection of knowledge.</li> <li>• Through formal and informal learning activities, integrate and absorb new information and knowledge ;</li> <li>• Actively participate in learning activities, in order to achieve the best learning effect ;</li> <li>• To put the new knowledge or skills in practical application in the work, through repeated practice to increase proficiency.</li> <li>• Without outside help, ability to solve problems by exploring and thinking through one's own</li> </ul>

### ***Detail Behavior Level Description of Dimensional Representation***

The developed competency model can provide the overall expectation of the employers. However, the desired degree or degree of the assessment which is critical important do not considered by the competency model. This section will be based on the above undergraduate competency model made by University-Enterprise Cooperation. According to the intended development outcomes of students, the enterprise development needs and all kinds of enterprises and all types of professional post requirements, formulate the behavior level defining the performance merits of all kinds of posts. Behavior level is mainly used for standard criteria for the assessment of the undergraduate competencies, and usually can be divided into 1-5 grades(Rubin Nancy, 2007).

Level 1 is the general competency requirements. It generally refers to the students can know and master basic concepts and terms, organization process or relevant tool use, also can carry on the simple analysis; Level 2 is for intermediate demand of ability quality, generally require students to fluently, independently carry out tool operation or to use knowledge of all aspects, and at the same time to carry on the simple education and management for other students or group members; Level 3 are sub-high level requirements for the ability quality. It generally requires students to master certain knowledge, processes or a particular aspect of tool use. It also can travel more complicated management functions; Level 4 are senior requirements for ability quality. It generally asks students to put forward strategic suggestions or make adjustments to the knowledge, processes or tools they grasped; Level 5 are the most senior requirements for the ability quality. It generally requires students to have enough foresight and insight to the development trend of things and the connotative problem.

Due to the limited length of the paper, table 3 only presents detail behavior level descriptions of cooperative ability in the TEAMWORK dimensional representation from the core competency model of operational excellence department. The detail behavior level descriptions of CRITICAL THINKING AND EFFECTIVE PROBLEM SOLVING dimensional

representation from core competency model related to the working position are shown in table 4.

Table 3. Detail behavior level description of the TEAMWORK dimensional representation

<b>2. Teamwork</b>	
Grade	Descriptions
5	<ul style="list-style-type: none"> <li>• Themselves have the courage to bear and help team members to assume their respective responsibilities, to work together</li> <li>• Adjust the priority of the task to achieve the team goal, self initiatively innovate style, timely adopt new methods</li> <li>• Suggestions or development of new methods, to maximize the participation and pay of team members</li> <li>• To promote cooperation within the organization and between different groups, to achieve common goals</li> <li>• Remove the barriers between teams (such as the organizational structure / function / culture etc.), promote the professional skills and resources sharing</li> <li>• Lead the related team to establish mutually beneficial win-win long-term relations of cooperation, through regular exchanges, strengthen and ascend partnership</li> </ul>
4	<ul style="list-style-type: none"> <li>• Able to undertake and help the team members to assume their respective responsibilities, and to establish effective cooperative relationship</li> <li>• To change the style and method with the help of the external force, can effectively drive team members to participate in and pay</li> <li>• Can help cooperation within the organization and between different groups, to achieve common goals</li> <li>• Help related teams to establish mutually beneficial win-win long-term cooperative relationship</li> </ul>
3	<ul style="list-style-type: none"> <li>• Take personal responsibility in a team, have a clear understanding of the team's goals and the roles and tasks of each member</li> <li>• Cooperate with others sincerely, justice, caring, respect</li> <li>• Take the initiative to provide support for colleagues, actively cooperate with colleagues rather than distorting competition</li> <li>• make good use of colleague's participation and pay, can listen to their views on the basis of independent analysis</li> <li>• Communicate with the various aspects, balance interests, persuade the parties to reach a consensus, work towards the common goal specified</li> </ul>
2	<ul style="list-style-type: none"> <li>• Can only assume personal responsibility in the team</li> <li>• Can cooperate with people, treat each other sincerely, balance interests</li> <li>• Able to provide support for colleagues, active cooperation between each other</li> <li>• Respect participation and dedication of colleagues, can listen to and adopt their point of view</li> </ul>
1	<ul style="list-style-type: none"> <li>• Prefer to work alone</li> <li>• Cooperate with people not humbly, not easy to establish and maintain relationships with others</li> <li>• Do not understand the important value of the differences between team members in the process of constructing the team</li> <li>• Be Insensitive to the needs and feelings of others</li> </ul>

Table 4. Detail behavior level descriptions of CRITICAL THINKING AND EFFECTIVE PROBLEM SOLVING dimensional representation

<b>5 Critical thinking and effective problem solving</b>	
Grade	Descriptions
5	<ul style="list-style-type: none"> <li>• Propose feasible solutions and contingency plans facing with problems</li> <li>• Propose solutions to problems with specific action plans and resource requirements, reach a consensus with stakeholders, promote the implementation of the plan;</li> <li>• Follow up the working schedule and its implementation to ensure problem solved; afterwards sum up experiences and share with others to firm proper operation and avoid the same problem.</li> <li>• Be not content with the current status, strive for excellence</li> <li>• Set higher standard and goal, persist in doing things better and better</li> <li>• Play a role of important driver of change</li> <li>• Seek for resources integration to improve organization functioning</li> </ul>
4	<ul style="list-style-type: none"> <li>• Able to undertake and help the team members to assume their respective responsibilities, and to establish effective cooperative relationship</li> <li>• To change the style and method with the help of the external force, can effectively drive team members to participate in and pay</li> <li>• Can help cooperation within the organization and between different groups, to achieve common goals</li> <li>• Help related teams to establish mutually beneficial win-win long-term cooperative relationship</li> </ul>
3	<ul style="list-style-type: none"> <li>• Timely propose or carry out possible solutions facing with problems</li> <li>• Offer needed resources to solve problems or make resource demands and follow up to ensure resources are in place</li> <li>• Implement and follow up the solution plan, ensure problems to be solved</li> <li>• Keep positive with the unsatisfied status quo</li> <li>• Actively seek and be willing to accept new ideas and ways of doing things to improve current processing systems</li> </ul>
2	<ul style="list-style-type: none"> <li>• Can only assume personal responsibility in the team</li> <li>• Can cooperate with people, treat each other sincerely, balance interests</li> <li>• Able to provide support for colleagues, active cooperation between each other</li> <li>• Respect participation and dedication of colleagues, can listen to and adopt their point of view</li> </ul>
1	<ul style="list-style-type: none"> <li>• Can not make decisions or propose a solution within a reasonable period of time;</li> <li>• Fail to offer the necessary resources or make resource requirements to solve problems</li> <li>• Just propose solution plan without following up or implementation</li> <li>• Be unawareness of improvement and be content with current situation</li> <li>• Act with anxiety and resistance to new changes and situations</li> <li>• Expect other colleagues initiate change</li> <li>• Accept new things slowly</li> </ul>

## **ASSESSMENT PROCESS AND METHODS OF ENGINEERING PRACTICAL ABILITIES**

After establishing the undergraduate student's competency model and its behavior grade, it is important to apply this model to the undergraduate students' comprehensive ability quality assessment process. In order to show the effectiveness of the new model, it is necessary to combined the new model with relatively complete evaluation system.. In addition, the most fundamental way to detect the competency model is performance management, and thus a set of objective, impartial, fair performance management system is critical to the establishment and perfection of the competency model.

### **Assessment Process**

In order to apply this competency model for assessment of the graduates' engineering practice ability, a complete assessment process need to be further designed. The main purpose of this process is to ensure that the evaluation of the graduates' engineering practical ability is more scientific, normative and accurate under certain conditions, and thus for the corporate HR to choose the right undergraduates adapted to corporate development and culture, for the university to improve its education quality and further revise its training objectives and curricula.

The following questions need to be answered in each step of the design of assessment process:

(1) What's the criterion of the assessment?

The undergraduate's competency model established above.

(2) Who are the raters?

The rater group incorporates 6 persons from both party of corporate HR department and the university, that is, three staff of HR chief director, director, and one technician from the enterprise and three of the department head, 2 professional teachers(professors) from STU. The enterprise plays a leading role in the process while the university assists.

(3) What methods would be more scientific for assessment?

Considering both characteristics of students and the enterprise, the assessment takes a method of two stages, which is detailed described in next section.

(4) What's the conclusion?

The conclusion is whether the assessed meet the enterprise's entry requirements of middle-level management/technical positions.

### **Assessment Methods**

The two-stage assessment method was led by the enterprise and designed by the university-enterprise assessing group. It relatively ensures the method to be scientific, normative and accurate.

Stage I : Stack up the plates

This stage was conducted in groups. 14 students were divided into 2 groups and performed 5-10 rounds of stacking up plates simultaneously as groups. The given time would be shortened as each round went on. The whole process might take 2 hours or so. After group discussion, the members are asked to sort a certain number of plates with numbers by ascending counts one by one and pass through a transit space to stack them up on another

pile in a given time. Interpersonal communication is not allowed in this process. The purpose of this stage is to evaluate the students' performance of the 8 dimensional presentations in the competency model in a teamwork situation.

### Stage II: Personal Interview

After teamwork project, both party designated one staff to form an interview group of 2. They will interview each student and ask the questions advised in table 5. The interview should be limited in less than 15 minutes.

Table 5 is based on the research conclusion of the previous sections, presenting a reference to student's interview assessment content and asking questions, which is very conducive to the application in the concrete operation of student assessment.

Table 5. Reference to undergraduates' interview assessment content and asking questions

Assessment content	Problems of reference ( Details please ask )
1. Core Competency	
①Mental and behaviours	<ul style="list-style-type: none"> <li>• Your mood is bad? For example, often pessimistic, depression, anxiety, irritability or irritable, like attacking etc.</li> <li>• Whether your work, study and attention are significantly decreased?</li> <li>• Whether there is abnormal and behavior you yourself can't control? For example, repeated washing, closing the door, making a face, etc.</li> <li>• See the elderly, children, beggars and other vulnerable groups, what would you do? Think what?</li> <li>• What do you think of the beautiful countryside teachers program?</li> </ul>
②Teamwork	<ul style="list-style-type: none"> <li>• Take a collective activity you have participated in for example, what is each team member's responsibility? And what kind of role did you play?</li> <li>• In this activity, whether there is any crew you don't like (him / way)? How did you handle it? And what's the result?</li> <li>• In the activities you experience, which one has the most intense time / task quantity, and how to collaboratively finish on time with team members?</li> </ul>
③Executive force	<ul style="list-style-type: none"> <li>• The most accomplished/the most proud of/ the most successful thing.</li> <li>• In the activities, if there is a situation where anyone has different opinions?</li> <li>• Tell a matter which cost less than expected, and the results were better than expected?</li> <li>• How did you prepare for the final exam? CET Four / CET Six?</li> </ul>

④ Leadership	<ul style="list-style-type: none"> <li>• As a project leader, if you have any experience that do not reach the expected target? Then how did you deal with it?</li> <li>• Please tell about a project you have recently led to complete? What procedures are you in to ensure the completion of the project on time and accurately?</li> <li>• In the activities you have experienced, which has the most limited resources? How did you work? ?</li> </ul>
<b>2. Competency model related to the composition</b>	
⑤ Critical thinking & solve problem effectively	<ul style="list-style-type: none"> <li>• Will you often use subversive ideas to think about a problem?</li> <li>• What is the most challenging / the most complex / the most difficult thing you encountered?</li> <li>• What solutions have you proposed? Choose which program? The result?</li> <li>• If you have such experience that your behavior or ideas avoid a potential problem?</li> </ul>
⑥ Innovation and Application	<ul style="list-style-type: none"> <li>• If you have such experience that you put forward a new viewpoint or ideas or methods in an activity making the activity very successful?</li> <li>• What aspects do you think the novelty of the idea is reflected?</li> <li>• When you told the new idea to the players, whether you ever encountered opposition and how did you deal with it?</li> </ul>
⑦ Communication & interpersonal communication	Through the process of asking questions, at the same time, inspect the candidates' communication ability.
⑧ Learning and independent thinking	<ul style="list-style-type: none"> <li>• In your recent study, are there no any special achievements?</li> <li>• If you have any experience that you were not satisfied with your grades? How did you change?</li> <li>• If ever found a classmate do hard on something, you helped him to complete? What was the situation? What did you say? Do?</li> </ul>

### **Assessment Results**

After the two-stage assessment, the interview group gave the assessment of each student, as well as a detailed description of the result, as is shown in ANNEX 1.

### **CONCLUSION**

Based on the work of CDIO engineering education reform, a undergraduate competency model, a standardized process to apply this competency model, and a method for the application of competency assessment were developed by Shantou University and Esquel Group..

Practice at Shantou University has shown that the newly developed method can be used to evaluating learning outcomes of the undergraduate students in different programs at STU. The assessment results can also bring benefit to the Mechanical Engineering Program for readjusting its training objectives, standards, curricula, and practice section.

### **REFERENCES**

Chinese Academy of Engineering Education Committee. Explore the Chinese engineering education reform road, Higher engineering education research, 2007, (6):43-47.

Edward Crawley, Johan Malmqvist etc. The CDIO Syllabus v 2.0 – An Updated Statement of Goals for Engineering Education[C]. Proceedings of the 7th International CDIO Conference, Technical University of Denmark, Copenhagen, June 20 – 23, 2011.

Gu Peihua. From CDIO to EIP-CDIO: explore engineering education and talents training mode in Shantou University. Higher engineering education research, 2008,(1):12-20.

Edward F. Crawley et al. Rethinking engineering education: the international CDIO training mode and method. 2009.

Anne F. Marrelli, Janis Tondora and Michael A. Hoge, Strategies for Developing Competency Models, Workforce Competencies in Behavioral Health, Volume 32, Numbers 5-6 (2005),533-561.

Bradley Elizabeth H; Cherlin Emily, Adopting a Competency-Based Model; Mapping Curricula and Assessing Student Progress, Journal of Health Administration Education, Volume 25, Number 1, Winter 2008,pp. 37-51(15)

Glenn M. McEvoy, James C. Hayton, Alan P. Wamick, A Competency-Based Model for Developing Human Resource Professionals, Journal of Management Education June 2005 vol. 29 no. 3 383-402

Mark A Albanese, George Mejicano, Defining characteristics of educational competencies, Medical Education, Volume 42, Issue 3, pages 248-255, March 2008

Rubin Nancy J.; Bebeau, Muriel, The competency movement within psychology: An historical perspective, Professional Psychology: Research and Practice, Vol 38(5), Oct 2007, 452-462

Rodolfa, Emil; Bent, Russ, A Cube Model for Competency Development: Implications for Psychology Educators and Regulators, Professional Psychology: Research and Practice, Vol 36(4), Aug 2005, 347-354

Bradley, Elizabeth H.; Cherlin, Emily, Adopting a Competency-Based Model; Mapping Curricula and Assessing Student Progress, Journal of Health Administration Education, Volume 25, Number 1, Winter 2008,pp. 37-51(15)

## **BIOGRAPHICAL INFORMATION**

**BAO Nengsheng**, is a Professor in Department of Mechatronic Engineering and vice dean of College of Engineering at Shantou University. His current scholarly activities focus on the management work of CDIO implementation in the college.

**Lu Xiaohua**, is a Professor in Department of Civil Engineering and Academic administration director of Shantou University. His current scholarly activities focus on the whole management work of higher education reform in the university.

**CHEN Yueyun**, is a director of human resources department, Esquel Group, Hongkong, China. Her main job duties in the enterprise are responsible for the cultivation of the students, human resources recruitment and training, etc.

### **Corresponding author**

Prof. Bao Nengsheng  
Department of Mechatronic Engineering  
College of Engineering  
Shantou University,  
Shantou City  
Guangdong Province  
China 515063  
(086)-13643059268  
nsbao@stu.edu.cn



This work is licensed under a Creative Commons Attribution-NonCommercial-NoDerivs 3.0 Unported License.

### ANNEX 1 : Student Ability Assessment Sheet

**Assessment Panel:** Song Qian & Chen Yueyun, Human Resources Department, Esquel Group  
 Bao Nengsheng & Chen saoke, Collegeing of Engineering, Shantou University

**Remarks :** 1) Please record the key behavior and performance of the participants' abilities in the typical behavior Column and grade them (one to five points).

2) Please record the comprehensive evaluation of participants.

NO. Student	Team work	Leadership	Innovation & Application	Communication & interpersonal communication	Learning and independent thinking	Critical thinking & solve problem effectively	Executive force	Comprehensive evaluation/Record
1	4	4	4	4	3	3	3	Be able to clarify the rules, put forward to the important points of view
2	3	3	2	4	3	2	3	The ability to solve problems is relatively weak. In the activities, he proposed the law of the maximum.
3	5	4	3	4	3	3	4	Record the rules in the activities; record the transfer process; strong sense of responsibility
4	2	2	3	2	3	3	2	Less participation in team activities; think alone; less put forward his own ideas; don't make decisions
5	3	2	4	3	4	3	2	Make clear goals Initiative; very sincere; lack of her own ideas
6	4	3	3	3	3	3	2	Good team members; not of enough self-confidence
7	4	2	4	2	4	4	2	Careful thinking; present a view of odd and even numbers; good problems solving ability; but there is a slight lack of communication skills

8	4	3	3	3	3	4	4	Put forward good idea; pragmatic; concern for all team members to participate
9	3	3	4	2	3	4	3	Results-oriented; assume responsibility; there is a slight lack of communication effect skills; sometimes there is no eye contact.
10	4	3	3	3	3	3	4	Focus on team work; awareness of activities; consider it was a "Pure physical labor work" about these activities, but the group didn't challenge successfully because it was a little loose.
11	5	3	3	4	5	3	3	Initiative to take responsibility and put forward the proposal; pragmatic and be good at continuous improvement; dedicated; be good at learning; clear expression
12	4	4	5	4	4	5	4	Be good at mathematical operation; summarize methods; record activity process; make overall planning; summarize the abilities of the team members.
13	4	4	4	4	3	3	5	Present more ideas; ensure team members are clear about the rules; good communication skills