

# *Teaching and Practice of “CAD and Chemical Engineering Cartography” Course in Independent College*

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**Abstract**— “CAD and chemical engineering cartography” is one of the compulsory professional foundation courses in independent college. In order to achieve effective teaching results, several measures are proposed to guarantee the reform of the course. These measures involve “selection of suitable teaching materials”, “formulation of reasonable teaching arrangement”, “development of effective teaching methods” and “establishment of scientific assessment system”. These measures ensured a synthetic and complete teaching content of the course, stimulated the students' interests and enthusiasms to learn the course, made the students easily and firmly understand and grasp the theoretic knowledge of chemical drawing and AutoCAD skills, and improved the students' abilities of independent drawing practice and innovation.

**Keywords**—chemical engineering cartography; AutoCAD, independent college; course reform

## I. INTRODUCTION

Drawing is one of the important basic tools for human to express, conceive, analyze and communicate their thoughts each other. It is widely used in engineering technology and called “the language of the engineer”. The process design, inspection and maintenance of any project or equipment production must be strictly based on the drawings. Different majors have different drawings, such as mechanical drawing, chemical drawing, architectural drawing, water supply and drainage drawing, et al. In the production, research and design areas of chemical engineering, bioengineering, biotechnology, food engineering and environmental engineering, the engineers, technicians and designers who work in these areas must possess the ability of reading and analyzing the chemical drawings and grasp the methods of drawing the chemical patterns. AutoCAD (Computer Added Design) is the general software package developed by the American Autodesk company dedicated to the computer graphic design work. It is a modern drawing tool with strong drawing function widely used

in today's various design fields. Compared with the manual drawing, the CAD drawing has many advantages, such as rapid, accurate, clear, beautiful, colorful and easy to save. With the development, promotion and application of computer technology, CAD drawing has replaced the manual drawing to meet the needs of chemical engineering design.

Nanchang University College of Science and Technology is an independent college built in 2003. The “CAD chemical engineering cartography” is one of the compulsory professional foundation courses for the students of pharmaceutical engineering, polymer materials and engineering, biological engineering, biological technology, applied chemistry specialties in the college. The course involves the map reading and drawing methods and the skills of CAD drawing. The purpose of the course is to cultivate the students' abilities of engineering consciousness, logical thinking and image thinking. It is important for the students to well learn the course for their successive courses of “Engineering Training” and “Graduation Design” and their future work[1-4]. In this paper, we mainly introduce some experiences of teaching and practice of “CAD and Chemical Cartography” course in our college.

## II. SELECTION OF SUITABLE TEACHING MATERIALS

Practically, “CAD and chemical cartography” is co-invested by chemical drawing and CAD, which should involve more complete and abundant contents, including basic engineering drawing knowledge, chemical drawings, AutoCAD technology and a large number of examples and exercises. So it is really necessary to select suitable teaching materials for the course. Compared with various of textbooks relevant to chemical drawing and AutoCAD recently published in domestic, the textbook of “Chemical Drawing” ( written by LIN Da-jun, YU Chuan-hao and YANG Jing, published by higher education press, China, the 8th reprint, 2011, ISBN 978-7-04-021944-9)[5] and its problem sets of “Chemical Drawing Problem Sets” ( written by GUAN Zhi-chao, LIN Da-jun and

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YANG Jing, published by higher education press, China, the 8th reprint, 2011, ISBN 978-7-04-021945-6)[6] were selected as the teaching materials. The textbooks have following characteristics. (i) It focuses on the relation between projection and form generation, which can enable the students to form strong abilities of spatial thinking and computer three-dimensional modeling. (ii) It gives priority to chemical drawings, especially provides more typical and standard patterns of process flow diagram with control points, equipment layout, piping layout and equipment assembly drawing, which is more suitable to the specialties of chemical engineering and related non-chemical engineering — not only to conform to the training goal of the students but also to be convenient for the teachers to teach according to the textbook. (iii) It embodies the modern new technologies, new methods and new standards, which can make the students, grasp these new technologies, methods and standards to solve the graphic expression problems in chemical design and therefore lay a solid foundation for their entering professional field after graduation. (iv) The language is fluent, simple and easy to read and the problems are explained and the theories are understood with practical examples, which can enable the students to better grasp the knowledge and skills, and to achieve twice the result with half the effort. (v) All the computer drawings or modeling instances are easily operated and have practical significance, through which the students may judge of the whole from one sample. (vi) It is equipped with corresponding problem sets and multimedia aided teaching CD, by which the students can do a

lot of exercises and receive the multimedia teaching to efficiently master the theories and skills. We selected the textbook entitled “Computer added Chemical Drawing and Design”(written by FANG Li-guo, published by Chemical Industry Press, China, 2013, ISBN 978-7-122-07745-5)[7] as the reference material because it introduces, in detail, many examples about how to draw the chemical equipment general parts by computer, such as sealing head (half spherical head, elliptical head, saucer head, taper sealing head), flange (pipe flange, container flange), adapter on cylinder or sealing head, manhole, hand hole and bearing, et al., which can greatly help the students to draw the parts in specification. We also recommend the CAD video teaching software entitled “AutoCAD2004 tutorial” to the students, which is very useful for the students to study and review the CAD drawing skills by themselves after class.

### III. FORMULATION OF REASONABLE TEACHING ARRANGEMENT

It is very important to formulate a reasonable teaching arrangement considering the course having more contents[8]. In order to conduct a effective teaching, the “module teaching method” is introduced in our teaching process. The whole contents are divided into four modules: basic knowledge of engineering drawing, chemical drawing, and basic skills of AutoCAD and CAD composite practice. The content and class hours of each module are described respectively in Table 1.

TABLE I. TEACHING ARRANGEMENT OF CAD CHEMICAL ENGINEERING CARTOGRAPHY

Module	content	class hours
Module 1	Basic knowledge of Engineering drawings	10
Module 2	Chemical drawings commonly used in chemical design	14
Module 3	Basic skills of AoutoCAD	21
Module 4	CAD composite practice	15
Total		60

There exist close relations among the four teaching modules. Following the principle of from theory to practice, from easy to difficult and step by step, the teaching order of the whole contents is arranged as: basic knowledge of engineering drawing→chemical drawing→AutoCAD→composite drawing. The teaching order of module 1 is: simple form→combined form→three view drawing of the practical object→view expression of parts→shape, position analysis and size marking of combined object→view expression of profile, sectional view and enlarge figure. According to the chemical engineering design and chemical construction process, the teaching order of module 2 is: program flow chart→material flow chart→construction flow chart→equipment layout→piping layout→typical chemical equipment and their commonly used components→assembly drawing of typical chemical equipment. The teaching order of module 3 and module 4 is: basic drawing

commands→status bars→basic modify commands→size marking→object properties and layer→composite drawing.

### IV. DEVELOPMENT OF EFFECTIVE TEACHING METHODS

In order to efficiently increase the teaching quality, several means are taken as follows.

#### A. Teaching with focusing on important points

It is important to capture the highlights of each module. The highlights of module 1 are: the forming rules of simple form and combined form and their differences; parallel projection of the plane of object; projection rule of the three view drawing; the nature and drawing of surface intersection line; drawing three view figure from actual object; imagining the actual object by the three view figure; optimization of views number; relative position and size marking of combined object; the section map, cutaway view and enlarged image of

object. The highlights of module 2 are: characteristics of chemical drawing; reading and drawing method of construction process chart; reading and drawing method of equipment layout; reading and drawing method of piping layout; type and selection of standard general components of chemical equipment; type of typical chemical equipment; type and selection of commonly used components of different chemical equipment; reading and drawing method of assembly drawing of typical chemical equipment. The highlights of module 3 are: type, usage and drawing method of each basic drawing and modify commands, status bars, size marking design and modify; The highlights of module 4 are: independently and flexibly apply the learned CAD drawing technology to draw a more complex chemical pattern by the students.

### B. Teaching with overcoming difficulties

Some knowledge points are difficult to understand for part of the students, especially those with poor image thinking and spatial thinking ability. In order to overcome the difficulties, the teacher repeatedly explains and the students repeatedly learn the knowledge points. The drawing of the intersecting line between two surfaces in three view figure is one of the difficulties of module 1. The teacher patiently and repeatedly gives the form and projection analysis and introduces the drawing method to the students. After that some of the students are asked to explain their understanding to the whole class until all the students have mastered the method. With the same measures, many difficulties have been overcome, such as the surface analysis method of object, structure, projection analysis and size marking method of complicated combined object [9], the understanding and distinguishing of various sectional figures, reading steps and drawing method of construction flow chart, equipment layout, piping layout and assembly drawing of complicated chemical equipment.

### C. Teaching with reflecting the educational idea of "student oriented"

AutoCAD is a highly theoretical and practical knowledge. In order to increase the students' abilities of theory with practice, independent design and innovation, we adhere to the educational idea of "student oriented" during the teaching process. The students are required to select any one of the more complicated chemical drawings provided by the teacher and use the theoretical knowledge and AutoCAD drawing skills learned in module 1, module 2 and module 3 to independently finish a construction flow chart or equipment layout, piping layout, assembly drawing of tank (or reactor with agitator, tubular heater, absorption tower, rectifying tower), while the teacher plays a guiding role. During the process, the students could fully play their advantages of quick acceptance of new things, flexibly and correctly use the drawing commands and modify commands as well as the other drawing skills learned and complete the figures in regulation by themselves. Through the composite drawing practice, the students' self-confidences, innovation consciousnesses and drawing abilities are greatly improved.

## V. ESTABLISHMENT OF SCIENTIFIC ASSESSMENT SYSTEM

It is significant to establish a scientific assessment system in order to fairly and truly evaluate the learning results of the students [10]. The system is composed of regular grade (30%) and composite drawing grade(70%). The score distribution is listed in Table 2 and Table 3, respectively.

TABLE II. SCORE DISTRIBUTION OF REGULAR GRADE

structure	proportion(%)	explanation
attendance	25	deduction of 2 scores for one late; deduction of 5 scores for one absence
attitude	25	seriously listen to the lectures, actively answer speak
classroom		
practice	25	answer teacher's questions, actively discuss, do the exercises
homework	25	deduction of 5 scores for one lack of pay
total	100	

TABLE III. SCORE DISTRIBUTION OF COMPOSITE DRAWING GRADE

Serial number	assessment	proportion(%)
1	Plan layout( neat) and proportion(suitable)	20
2	integrity of the drawing content	30
3	size marking	10
4	title bar	10
5	correctness of drawing	20
6	standardization of drawing	10
Total		100

The scientific assessment system has received good effects. The students could consciously abide by the classroom

discipline, actively take an active part in class discussions and answer questions from the teacher, carefully do the homework

and complete the composite drawing according to standards and specifications.

## VI. CONCLUSIONS

Suitable teaching materials ensured a synthetic and complete teaching content, accorded with the requirements of teaching outline and met the needs of chemical, pharmaceutical and biological engineering design. Reasonable teaching arrangements made the students easily and firmly understand and grasp the theoretic knowledge of chemical drawing and AutoCAD skills. The proposed teaching measures stimulated the students' interests and enthusiasms to learn the course, increased their AutoCAD drawing skills and improved their abilities of independent drawing practice and innovation.

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