The Use of Computer-Aided Design in Small Contractors in a Local Area of Korea

Myunghoun Jang

Abstract—A survey of small-size contractors in Jeju was conducted to investigate college graduate's computer-aided design (CAD) competence. Most of small-size contractors use CAD software to review and update drawings submitted from an architect. This research analyzed the curriculum of the architectural engineering in several national universities. The CAD classes have 4 or 6 hours per week and use AutoCAD primarily. This paper proposes that a CAD class needs 6 hours per week, 2D drawing is the main theme in the curriculum, and exercises to make 3D models are also included in the CAD class. An improved method, for example Internet cafe and real time feedbacks using smartphones, to evaluate the reports and exercise results is necessary.

Keywords—Computer-aided design, CAD education, education improvement, small-size contractor.

I. INTRODUCTION

DRAWINGS are the beginning and end of architectural design, and the basic components to construct a building. Some architects draw lines by hand, but most design studios use a CAD software to make drawings easily and quickly. A few people thought that CAD might spoil design quality in earlier time when CAD was adapted. However, CAD increases productivity and improves communication between stakeholders, so CAD is widely used nowadays [1].

Many colleges have CAD classes in a regular curriculum. Students in the department of architectural engineering should take a CAD class. But, the level of CAD in class is basically low. This makes mismatch between the college and construction companies. This research focuses on the mismatch and investigates how to use CAD in construction companies in local area in Korea to decrease the gap of the college and the companies. The research analyzes CAD skills and technique required in the companies and proposes how to teach CAD in a class.

II. USE OF CAD IN SMALL CONTRACTORS

A. Question Respondents

45 small contractors in Jeju responded to the survey of CAD use from Sep. to Oct. 2015 using phone, e-mail, and fax. The contractors are so small that they are ranked in the class 5, 6, and 7 by the Classification of Public Procurement Service. Fig. 1 shows that 30 contractors have 10~29 employees, and two contractors have over 50 employees. The respondents had various employment period from 1 to 20 years in construction

Myunghoun Jang is with the Department of Architectural Engineering, Jeju National Unversity, Jeju, 64243 South Korea (corresponding author, phone: 82-640754-3704, fax: 82-64-757-8691, e-mail: jangmh@ jejunu.ac.kr).
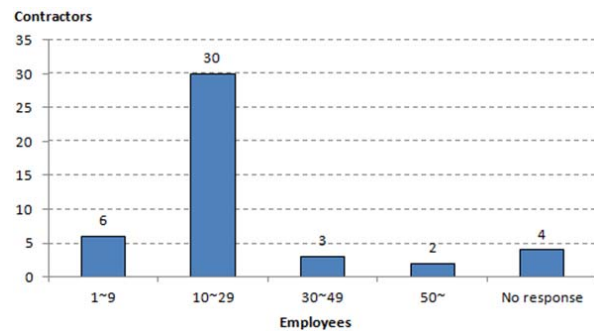
companies.

Fig. 1 Number of employees

B. Survey Contents

According to the response results, most small contractors (91%) use AutoCAD as shown in Fig. 2. SketchUp is used by only one contractor. Three contractors do not use any CAD software.

Fig. 3 shows that there is no staff (42%) responsible for managing drawings and CAD software, and a general manager or an assistant manager (29%) takes the responsibility.

As the result of usage level of CAD software, field managers can update and add drawing components in the existing drawings (42%) as shown in Fig. 4. 33% of respondents make new drawings, 16% review drawings to communicate with an owner and an auditor. 7% do not use any CAD.
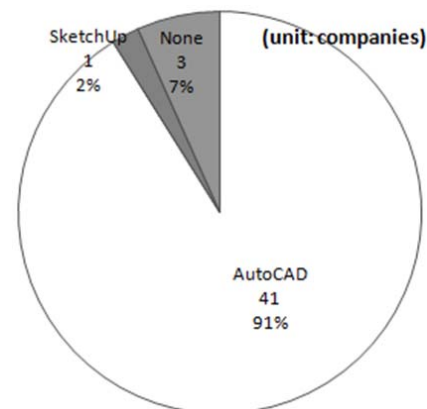

Fig. 2 Type of CAD software

58% of responses to the level of CAD capacity for a graduate of architectural engineering required the level to modify, add, and delete contents of a drawing. 24% wanted the level to make

3D drawings. The levels to check drawing contents, and to draw a perspective drawing were for 9% and 5%, respectively. 4% of the respondents said that CAD was unnecessary in their work.
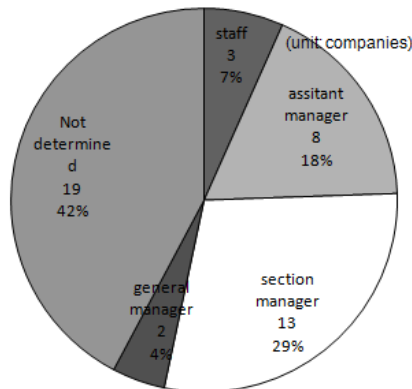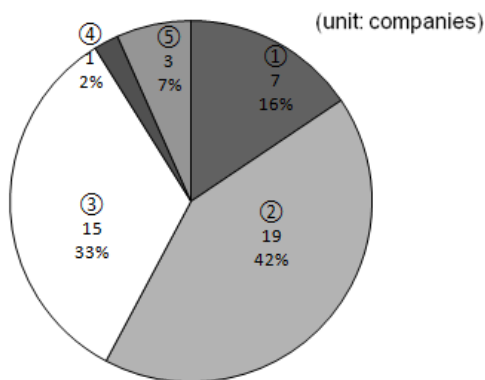

Fig. 3 Responsible to manage the CAD software

① To review for communication among stakeholders
② To modify drawings and add elements
③ To make a new drawing like details
④ To draw 3D perspectives with 2D drawings
⑤ To rarely use CAD software

Fig. 4 CAD utilization level

III. CAD EDUCATION IN COLLEGE

A. CAD Classes in Korean Universities

CAD classes of architectural engineering in several universities of local areas in South Korea except Seoul and Gyounggi-do are surveyed because most small contractors work in local areas. Table I shows that there are 18 universities in the survey, one in Gangwon-do, 5 in Chungcheong-do, 4 in Jeolla-do, 7 in Gyeongsang-do, and 1 in Jeju-do. 15 universities operate the accreditation programs for engineering education, while three have no certification programs.

There are nine universities that include CAD in the name of the curriculum. Architectural Drawing or Digital Architecture is named for a CAD class in the other nine universities. CAD

classes are comprised mainly in the sophomore year. Three universities organize them in the freshman year, and only two universities in the junior year. Most of the universities teach CAD in the sophomore year because CAD is one of the basic courses and the base of construction, structure, and environment of architectural engineering.
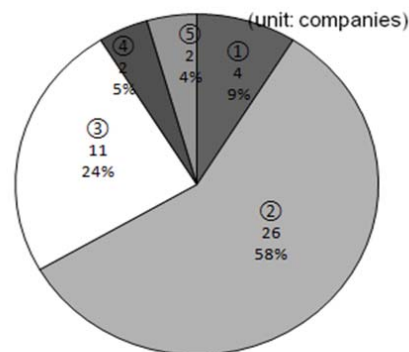
① To review the drawings provided by an architect
② To modify drawings and add elements
③ To draw 3D drawings with 2D drawings
④ To draw 3D perspectives
⑤ unncessary

Fig. 5 Graduates' ability to use CAD

TABLE I
CAD COURSES OF NATIONAL UNIVERSITIES IN KOREA

Region	Univ	Course title	Year	Semester
Kangwon-do	1	CAD	2	2
Chungcheong-do	2	CAD	2	2
	3	Architecture and Computer	2	1
	4	CAD and Lab	1	2
	5	Computer Graphics	2	2
	6	CAD in Architecture	2	2
Jeolla-do	7	CAD	3	2
	8	CAD & Architectural drawing	2	1
	9	Computer Science Foundation & Application	2	1, 2
	10	Digital Architecture	2	2
Gyeongsang-do	11	Architectural CAD	3	1
	12	Graphics Practice, Computer Practice	2	1, 2
	13	CAD	2	1
	14	Architectural BIM 1, 2	1	1, 2
	15	Digital Architecture Design	3	1
	16	Architectural CAD 1, 2	3	1, 2
	17	Architectural Computer Science 1, 2	3	1
Jeju-do	18	Architectural drawing & CAD	1	2

B. Reviews of CAD Classes and Researches

According to the survey [2] on CAD class, the students replied that they want to learn AutoCAD (37.5%), SketchUp (37.5%), and PhotoShop (12.5%). The survey said that the students preferred the practice method of teacher lecture - a student practice (23.3%) more than teacher lecture - two or three students practice together (21.9% respectively).

The case [3] in Jeju National University used a web board to submit students' reports and to feedback their teacher's comments. The online evaluation of assignments has the advantage of being able to supplement the shortage of the number of lessons and facilitating the teacher-student interaction.

Recently, the importance of Building Information Modeling (BIM) is increasing. BIM education in the university has been gradually expanded to the practice of 4D and 5D. BIM related theory and research were centered on several graduate schools, starting from the conversion of the 2D-based design into 3D [4]. BIM was also introduced in the architectural engineering design process, and the improvement of overall education process through integration of 3D modeling, structural analysis, construction management, and eco-friendly houses was suggested [5].

C. CAD Class in Jeju National University

The department of architectural engineering in Jeju National University had operated a single major until 2002, and the department was reorganized as two majors in 2003. One is architectural engineering (4-year course), and the other is architectural design (5-year course). CAD classes were open every year prior to 2003.

CAD class of the department of architectural engineering has 2 credits and 4 hours per week. It includes the theory and exercise of AutoCAD, and the use of SketchUp and ArchiCAD is also taught in the latter half weeks. Exercise for architectural draft is necessary from 2009, then time for AutoCAD decreases. But, SketchUp course increases as the need for 3D modeling grows.

D. Improvement Plan for CAD Class

The university education in the digital age can be said to be nurturing competent resources of the nation and nurturing the technicians that companies need [6]. But, it is difficult to satisfy the objectives of the university education. A new employee working for Korea Land and Housing Corporation said that his university education is not enough for his works in the company [7]. In order for the department of architectural engineering to move forward, it is necessary to actively develop a curriculum that meets the needs of the industry and cultivates suitable talents through corresponding education [8].

These are the improvements for CAD class as follows.

a. Contents of CAD class: According to the survey results, smallest contractors use AutoCAD to view 2D drawings and to verify that a building or a structure is built as planned. When a small contractor takes part in a big building project, the contractor has to use 3D drawings.

Most of the departments of architectural engineering educates CAD using AutoCAD. Theory and practice to draw floor plan, elevation, section, and detail drawings using AutoCAD in a CAD class are appropriate. Furthermore, it is more necessary to teach how to draw a perspective drawing by given floor plans and elevations rather than teaching to make a 3D drawing.

A 3D model or perspective is needed to improve students' ability to design. A 3D modeling tool like SketchUp enhances comprehension of space, and allows to review the 3D model in a variety of locations.

CAD software requires diversity. AutoCAD has a very high share of the local architectural design software market [9]. Most architectural design offices and construction firms must use AutoCAD. It is very expensive and it is a burden to small construction companies.

b. Time for lecture and practice: The survey of CAD courses in Korean national universities shows that each class operates one or two semesters. The one-semester classes have the curriculum to draw 2D drawing, and deal a basic part of 3D modeling. The two-semester classes include the detail of 2D drawing and 3D modeling.

The score and time vary in each CAD class in the universities, such as 2 scores and 4 hours, 3 scores and 4 hours, and 3 scores and 6 hours. The class of Jeju National University has 2 scores and 4 hours. It does not have enough time because a professor needs to teach the CAD theory, and his/her students have to practice their studies.

Since the university needs to take all classes in one semester for two hours, the professor needs to learn about the theory, so the students have to practice their studies and do not have enough time.

c. Performing and evaluating tasks: Students' practice is essential for a CAD class. It takes about an hour to explain theoretical instruction for four hours of the class. The students practice their lessons and the professor coaches them individually for the remaining three hours.

Depending on the degree of difficulty or quantity of the exercise, the amount of time needed to accomplish tasks varies, but three hours are insufficient for exercise. Moreover, it is difficult for one professor to teach 20 to 30 students.

The results of the CAD exercise are drawing files. The instructor should identify and evaluate each submitted file and should provide feedback in order to confirm the results of the assignment, in addition, because the class is held once a week, there is a week gap in evaluation and feedback on the results of the task, and the learning effect becomes less effective.

The CAD class of Jeju National University provides a web board to submit the assignments and to give teacher's feedback to solve these problems as shown in Fig. 6. Even if a student fails to submit the assignment within the class time, the student submits the assignment to the bulletin board of the assignment cafe. The teacher evaluates the submitted assignment and responds back to the bulletin board with feedback. Students and the teacher can view assignments, evaluations, and feedback in real-time via a smart-phone app.
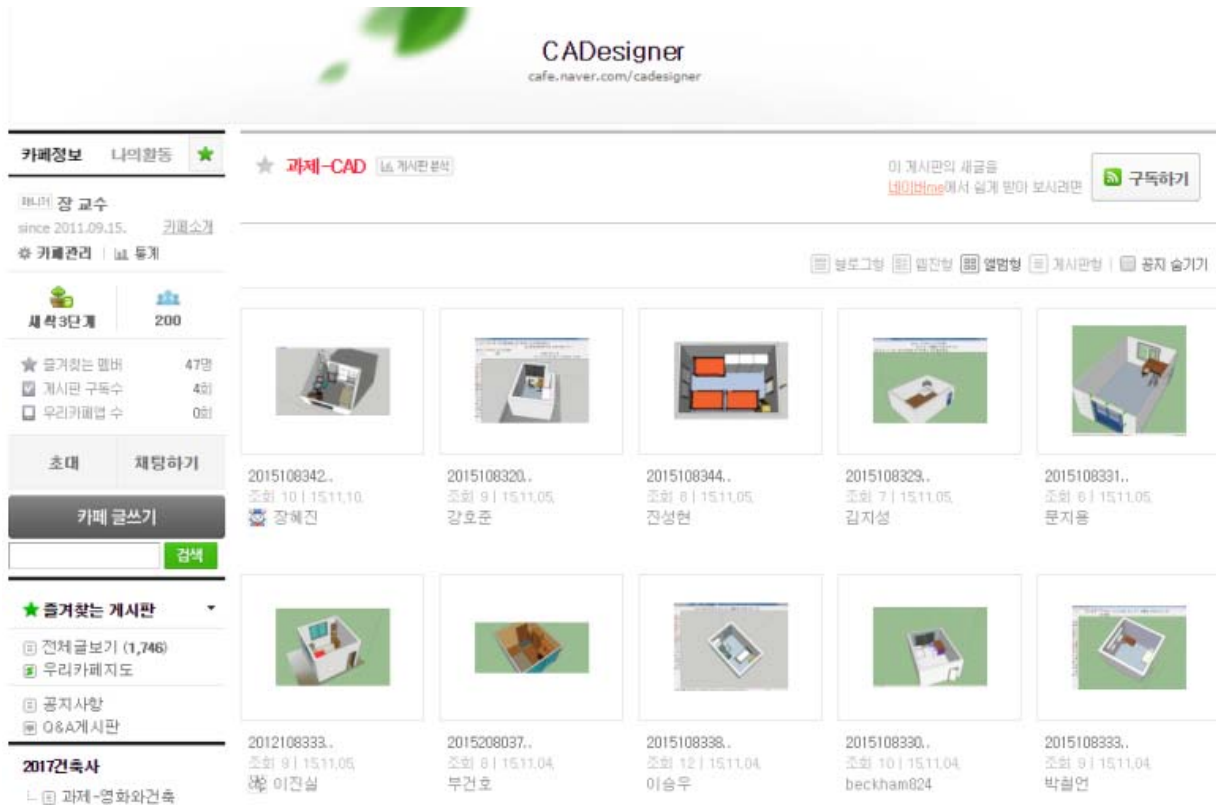
Fig. 6 A bulletin board for the CAD class

IV. CONCLUSION

Small construction companies in Jeju use AutoCAD to modify the existing drawings. A student majoring in architectural engineering needs the ability to handle CAD functions to get a job in a construction company. In the CAD course of the university, it is necessary to prepare a teaching plan to learn the necessary skills in practice.

Small construction companies mainly use AutoCAD. Most universities are working on AutoCAD, such as creating 2D drawings. Because of the growing need for 3D models, other 3D modeling software besides AutoCAD should be used in the CAD classes

CAD class hours vary from 4 hours (2 credits) to to 6 hours (3 credits). Four hours of practice are not enough for one semester, so it needs to be expanded to 6 hours or extended to two semesters. Evaluation and feedback are important for practical exercises. The lack of practice time makes this difficult, so it is necessary to improve the existing method. Since the output of the CAD project is a computer file which is not printed, it is necessary to actively utilize the Internet bulletin board.

Changing the grade and time of the CAD class has difficulty in considering the relationship with other classes in the department, timetable, and so on. However, the contents of the changed class, submission of tasks, evaluation and feedback methods should be applied to future classes and real-time feedback using smart phones needs to be introduced.

The analysis of the CAD use of small contractors in this study is limited to some areas. The research area will be expanded in the future in order to cover the needs of various universities.

REFERENCES

[1] W. Y. Kim, "Introducing 3D CAD to advance construction techniques," *The Construction Business Journal*. Vol. 72, pp. 63-65, Apr. 2007.
[2] Y. C. Nam. "Study on the Student Surveys for CAAD (Computer Aided Architectural Design)," *Journal of The Korean Digital Architecture -Interior Association*, vol. 12, no. 4, pp. 117-124, Dec. 2012.
[3] M. Jang, "A Case Study on Engineering Education of Architectural Engineering CAD Using Blended Learning," *Journal of the Korea Institute of Building Construction*, vol. 12, no. 4, pp. 426-432, Oct. 2012.
[4] H. M. Moon, "Case Studies in BIM Education," *KIBIM Magazine*, vol. 2, no. 1, pp. 38-41, Mar. 2012.
[5] D. Y. Kang, and K. C. Shin, "Improvement of architectural engineering design education process through an analysis of BIM courses," *Journal of the Korea Institute of Building Construction*, vol. 10, no. 3, pp. 145-153, Jun. 2010.
[6] S. B. Lee, "Paradigm change of education for architectural engineering," *Building Construction (KIBC magazine)*, vol. 3, no. 4, pp. 56-57, Dec. 2003.
[7] N. J. Park, "Freshman's thought of college education in Korea Land & Housing Corporation," *Construction Engineering and Management (KICEM magazine)*, vol. 15, no. 2, pp.30-32, Apr. 2014.

[8] G. H. Kim, "Present and future of construction-related college education," *Construction Engineering and Management (KICEM magazine)*, vol. 15, no. 2, pp. 27-29, Apr. 2014.

[9] H. S. Shin, "Case study of AutoDesk distribution," *Journal of Sustainability Management*, vol. 7, pp.17-37, Aug. 2010.

Myunghoun Jang and was born in Jeju, Republic of Korea on May 27th, 1970. He received his PhD in architectural engineering from Seoul National University, Seoul, Republic of Korea in 2002. His research interests are construction management, building technology, and safety.

He worked for Daewoo Engineering and Construction from 2002 to 2005. He is a professor in the Department of Architectural Engineering at Jeju National University, Republic of Korea. He is involved in the editorial committee of Korea Institute of Building Construction, and the editorial committee of Korean Journal of Construction Engineering and Management.