The Curriculum Goal Achievement Evaluation Design of IC Design and Integrated System Excellent Engineer CDIO Training Mode

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Abstract. The undergraduate major of integrated circuit design and integrated system is an undergraduate major with strong engineering practice. The practice teaching system is very important in the whole training plan of the major components. It plays an important role in talent training quality. This paper studies the practical teaching system of integrated circuit design and integrated system undergraduate major, including construction idea, construction plan, etc. With the acceleration of scientific and technological innovation, the new technological revolution has given new contents to industrialization. Whether it is in China or in the world, the transformation of engineering has brought about new requirements for talent cultivation. On this basis, the education mode of CDIO engineering was carried out, which further accelerated the reform of engineering education. Through the case analysis of professional courses for integrated circuit design and integrated system, it uses the total linear module curriculum structure redesign the professional curriculum system structure based on CDIO.

1. Introduction
CDIO is a model based on project learning. It is a kind of engineering education "middle school". As the carrier, in the project life cycle, it cultivates the students' academic knowledge, professional ethics and the ability to use knowledge to solve problems [1]. The education model launched by the Massachusetts institute of technology (MIT) and the royal Swedish institute of technology has been used by dozens of universities and they are recognized by the industry. Education reform and the introduction of CDIO education mode are very necessary.

Education is a professional education which is based on the completion of medium education. It is a social activity to cultivate senior professional talents. Professional education is necessary to develop knowledge and skills. Therefore, professional education also refers to professional technology education or industrial education. "Higher professional education" is a combination of "higher" and "professional education".

2. The course of CDIO
CDIO integration course is an integrated professional course. The capacity building of the system is the general plan of the teaching plan, namely, the concept of CDIO (concept - design - implementation - operation) concept [3]. Without any increase in teaching content and time, it is on the basis of adjusting and optimizing the original teaching plan, which integrates the knowledge, abilities and attitudes and professional skills and the integration of humanistic quality education. The CDIO body also is "high school" and "education and learning" based on the project. We recognize that these three changes are not the traditional teaching methods, but the teachers as the center of the students. This course is centered
on the textbook, centered on the class, with experience and ability as the center. It emphasizes the purpose and initiative of learning.

The theory of curriculum system has guiding significance for research and design. This course aims to cultivate students’ ability to analyze IC. This course can also be found in the traditional curriculum design integration system [5].

Based on reports, it is now a common course of integrated circuit design and integration system in our school. The professional basic courses and professional courses were redrawn, as shown in Table 1. Then we compare the Massachusetts institute of technology (MIT) of aerospace engineering professional course (The QS world university rankings at the Massachusetts institute of technology have become the standard for measuring education in the CDIO project.) After analyzing the integrated curriculum of IC design and integrated system in China, we find some existing problems as follows: (1) engineering experiment course proportion are low. Only 22 percent of the students in the engineering analysis design and experimental class took the initiative, well below the basic scientific theory of course, while in 2014 at the Massachusetts institute of technology carrier space engineering professional course system of practical courses for credit ratio is 43%; (2) the proportion of humanities and social science courses are below 10%. (3)-elective courses are insufficient. Less than 5% of elective courses are optional. The proportion of elective courses in the MIT curriculum system is 57% [6], and the non-limit optional course is 24%. The setting of a large number of elective courses gives students the initiative to learn and respect the development of students' gender development and innovation.

Table 1. Professional courses in integrated circuit design and integration systems determined by the organization.

| Curriculum organization | Basic science | Engineering Science | Engineering analysis and design | Engineering experiment | The department of engineering courses | Humanities and social science | else |
|-------------------------|--------------|---------------------|-------------------------------|-----------------------|--------------------------------------|-------------------------------|------|
| Credits proportion      | 0.21         | 0.39                | 0.12                          | 0.10                  | 0.09                                 | 0.08                          | <0.05|

Compared with traditional curriculum system, it has obvious advantages: first, through the planning guided by professional direction, students can choose them according to their own interests and their own demand for the purpose of their aptitude; Second, it sets up a team to develop the curriculum and complete the project, breaking the traditional teaching system of sub-class where students have discussed with each other, and communication can help solve problems and foster teamwork awareness. Third, it realizes the mutual support and contact between the disciplines, each student on a course can know clearly the course and the connection between the courses and subsequent courses, and the learning goals of the entire curriculum system. Fourth, the study from the first to the sixth semesters gets students well prepared for the implementation of the final project, and also helps them improve thesis quality as well as avoid fraud. Fifth, in terms of curriculum organization, the main project compulsory courses are greatly reduced, mean while, in addition to the basic courses and professional courses, professional foundation courses are set as an elective courses, making students have more options for cross major learning, as shown in Figure 1. In addition, public courses such as humanities and social sciences are integrated into the whole university curriculum to realize the integrated cultivation of professional skills and humanistic quality.
At the same time, the curriculum system of the current teaching mode raises the corresponding requirements, such as the reform of students’ learning, teachers’ teaching and training, and teaching materials, as well as the evaluation of students [8].

IC layout design professional standards required by the necessary basic knowledge and basic skills to the content of this course is divided into multiple modules: basic module (system operation), application module (software using partial), basic skill training module (basic unit layout design), skills upgrading module (overall layout and project control), and other four modules contain eight situations. The concrete content includes: the Linux foundation, map reading and circuit extraction, the design rule summary table sorting, drawn in accordance with the design rule of NAD2 / NOR2 map, DRC and LVS verification and conflict identification and modification, and standard cell of the frame structure of the formulation, standard cell layout design, chip CD4013 layout design and so on, each situation is corresponding to a particular part of the work. These situations can not only provide cognitive opportunities for the students, but also stimulate the initiative of autonomous learning.

We should train students’ vocational skills, require students to practice according to the standards of the enterprises, submit the project summary reports and group to improve the progress report. This will lay the foundation for the future development of the enterprises.

The CDIO system of IC layout design course has completed the construction tasks according to the following framework, as shown in Table 2.
Table 2. Study situation table of integrated circuit layout design

| learning situation | period | ability object |
|--------------------|--------|----------------|
| 1. The Linux foundation | 5 | Linux base, graphical interface and command line interface switch. |
| 2. Map reading and circuit extraction. | 9 | Understand the MOS device structure, understand the digital logic, inverter layout, and master the use of Virtuoso. |
| 3. Design rule summary | 6 | Understand the design rules, use the rule compression area to the maximum extent, understand the requirements of the manufacturing process rules for the design, and be able to sort out the easy-to-read tables from the complex design rules file. |
| 4. Draws a map that conforms to the design rule of NAD2/NOR2. | 11 | To understand the correspondence between the three-dimensional structure and the layout of MOS devices, and to distinguish the MOS tube and its connection from the layout and geometric relations. |
| 5. DRC and LVS verification and conflict identification and modification | 12 | Proficient in DRC and LVS verification process training correction ability. |
| 6. Standard cell's framework is developed. | 5 | Define the principles of standard unit frame structure. |
| 7. Standard unit layout design. | 13 | Learning standard unit drawing method, set oai21/aoi21 and other standard single elements, gong DRC, LVS process. |
| 8. Chip CD4013 layout design | 15 | Standard unit calls, PAD part drawing skills, reasonable layout and to ensure that the validation by DRC, LVS |

3. Human resource planning model based on multi objective programming

Under the guidance of the CDIO syllabus, the curriculum design of integrated circuit layout design is as follows: with real projects from enterprises (such as design rule profiles, seen in Table 3) as the carrier, Students need to learn and master the content of project design to form a whole. Teachers should pay attention to the teaching of knowledge system and improve their professional skills. They should organize teaching with the main line of professional ethics development, happy teaching and happy learning, and guide students to study actively.

Teachers adopt bilingual teaching courseware and notes, as well as bilingual in-class teaching; meanwhile, students finish their homework in two languages, so as to strengthen professional vocabulary learning, which lay a good foundation to adapt to the working environment. According to enterprise standard construction, the content is advanced and practical. Using the SUN workstation, which is consistent with many research and development design companies, a UNIX/LINUX system based network is established, and Cadence tool software is widely used in the layout design. Enterprising project training. It includes enterprise research and development projects, reverse engineering, design rules summary, DRC and LVS verification and conflict identification and modification, establishment of standard cell library, design of chip CD4013, etc. In a real environment (carried out in accordance with the enterprise standard training room configuration), the productive real training task, curriculum
development and teaching task of teachers have many years in foreign enterprise research and development design engineering background. Comprehensive evaluation system. It combines theory and practice evaluation, skill training and the combination of table and training, the combination of teacher evaluation and enterprise evaluation, and the combination of students’ self-assessment and mutual evaluation. Evaluation aspects include learning attitude, writing project report, practical investigation and theoretical test (according to the four levels of difficulty and landscape design professional standards drawn from the question bank in random questions) enhance teachers’ teaching skills. Young and middle-aged teachers and engineers have the experience of in-house training courses and enterprise project participation, and require new courses and experiments and training programs every year. Each month is conducted business and management capability evaluation and term assessment. The training should be communicated with the project report and training experience. At the same time, the job rotation should be carried out, so that the teachers are familiar with the core technology. Professional teachers promote the combination of teaching and production through in-depth enterprise training and enterprise training. The teachers are both lecturers and training instructors, as well as trainers and project engineers to promote the cultivation of "dual-qualification teachers ".

Table 3. "design rule summary table" situation design based on CDIO mode

| Learning situation 3: design rule summary. | 4 hours: |
|------------------------------------------|----------|
| 1. learning target                       |          |
| Be familiar with the simple Process of p-sub n-well SPDM Process, specify the meaning of minimum spacing and minimum width of design rules, and the influence of design rules on the Process, and can extract the simplified form from the complex rules. |
| 2. The teaching method suggests task drive, teacher demonstration and student imitation |
| 3. Teaching implementation work process task teaching organization study time information. |

| course of work | work task | teaching organization | period |
|---------------|-----------|----------------------|--------|
| message       | 1. Design rules manual | Publicize project tasks and clarify task contents; To provide information advice and to provide methods and information for obtaining information; Focus on understanding the content of the design rules. | 0.5 |
|               | 2. Be familiar with basic design rules. | | |
|               | 3. Grasp the basic concepts in the rules. | | |
| plan          | 1. Clear design rules; 2. Extraction of basic rules | Question the feasibility of the plan, provide guidance to the working process, and help to form an executable work plan. | 1 |
| implement     | 1. Understand the design rule; 2. Define the relationship and significance of design rule's requirements and product reliability; | Focus on the understanding of the design rules and the readability of the summary table. | 2 |
3.0 master the design rule in the production process

| Assessment | 1. Analyze the working process and review the work result;  
2. Complete the personal task report | Evaluation of project quality, attention to industry ground handling evaluation, etc | 0.5 |

4. Object: SUN workstation, LINUX operating system, Design Rule

5. Tools: SUN work stations, the PC terminal end, LINUX operating system, bureau of domain network, EDA tools (cadence)

6. Teaching focus: understand the Design rule, specify the minimum distance, minimum width and other parameters on the process of my mobile phone 2018/4/1 22:23:51.

7. Assessment and evaluation: 60% of results, 20% of teachers’ evaluation and 20% of self-evaluation.

To judge whether teaching quality monitoring system is good or bad, not only depends on the evaluation results of the students, but also needs to establish a special system of teaching supervision to conduct regular spot check and supervision of classroom teaching. Most importantly, it can help cultivate outstanding graduates. When these graduates enter the society and the enterprises, they can obtain the enterprise’s affirmation, which is the most objective evaluation of our course quality.

4. Conclusion

Around the CDIO concept, we can build a professional curriculum system structure of integrated circuit design and process integration, namely: according to the direction of the professional guidance, we will guide the project integrated into the learning ability training theory, the process of applying knowledge to the practice of project. Through the reform of the curriculum system, we hope to integrate the students’ knowledge, ability, and research attitude, as well as cultivate both their professional skills and human literacy. At the same time, this has certain guiding significance for the reform of the engineering curriculum system in China's universities.

References

[1] Gu P H, Bao N S, Kang Q L. CDIO in China[J]. Higher engineering education research. 2012,3:24-40.

[2] Dai Y. The innovative higher vocational training mode should focus on three levels of reform[J]. 2007

[3] Zhu W W, Xie S Y. A case study of education project in MIT and its implications for the continuation of education in Chinese universities[J]. Research on education of higher engineering, 2014, 6:130-135.

[4] Zhang Y X. The reform orientation of education talent cultivation model in higher vocational colleges[J]. 2008, 19:20-22.

[5] Li X, Zhang F, Bai Z, et al. A new assessment and evaluation system for an engineering course, based on the CDIO model[J]. World Transactions on Engineering & Technology Education, 2014, 12(3):473-478.

[6] Muldoon S F, Bridgeford E W, Bassett D S, Small world properties and weighted brain networks[J]. Scientific Reports, 2016, 6:22057.

[7] Monson M S, Cardona C J, Coulombe R A, Reed K M, Hepatic Transcriptome responses of domesticated and wild turkey embryos to aflatoxin B1[J]. Toxins, 2016, 8(1):16.
[8] Stefan H, Gerhard R, Kai O. Hydrophobin based surface engineering for sensitive and robust quantification of yeast pheromones[J]. Sensors, 2016, 16(5):602