

## Design and Implementation of Level-Three Projects based on TOPCARES-CDIO Engineering Education

Wei DONG<sup>1, a</sup>, Lixin MA<sup>2, b</sup>

<sup>1</sup>Education Quality Management & Assurance Office, Dalian Neusoft University of Information, Dalian, 116023, China

<sup>2</sup>Department of Computer Science & Technology, Dalian Neusoft University of Information, Dalian, 116023, China

<sup>a</sup>email: dongwei@neusoft.edu.cn, <sup>b</sup>email: malixin@neusoft.edu.cn

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**Abstract.** The importance of Level-three project as the base, bone and main thread in training schemes, courses group and courses, based on TOPCARES-CDIO engineering education is proposed in the paper. It is also maintained that how to design Level-three projects from the training schemes, courses group and courses. Finally, three implement ways are put forwards: integrated, centralized and distributed, which have provided a good reference about the design and implement of Level-three projects.

### Introduction

CDIO is the newest achievements of the international engineering education reformation<sup>[1]</sup>. Dalian Neusoft Institute of Information localizes the CDIO, and proposes the integrated personnel training mode of the TOPCARES-CDIO originally<sup>[2]</sup>. The integrated personnel training mode of the TOPCARES-CDIO, focuses on the design and implement of the projects. There are four levels projects: Level-one (the cornerstone and capstone project), Level-two (the courses group project), Level-three (the course project) and Level-four (the unit group project). Therefore, level-three project, as a role of advancing the ability of the course, takes an important role in the whole personnel training mode as a connection. This paper, starting with the design of the level-three project, describes the different ways of the design and implement of the level-three project through the real cases.

### Roles of Level-three Projects

#### A. Role in the Training Scheme

If the personnel training are considered as building, the personnel training scheme will be considered as the building drawing. The figure 1 shows the idea of the integrated personnel training mode of the TOPCARES-CDIO, which is a construction of “I” by the projects of the every level. The cornerstone project as the level-one project, offered in the first year, guides the whole training scheme, which is the foundation of the training scheme. The implement of the project groups made by the level-two, level-three and level-four projects, runs through the first year to third year in college, which, deeper by levels, advances the core abilities. At last, in the fourth year, the capstone project, as the integrated training of all the knowledge and abilities, draws a successful ending of the personnel training scheme. The personnel training scheme focuses on the “Design-Implement” experience, and as an important characteristic, the level-three project will be a primary experience of the “Design-Implement”.

It turns out, the level-three projects are closely related with the level-two projects and the level-four projects. The level-three projects link up the level-four projects of the course, and support the level-two projects, that the level-three projects are the foundations.

### B. Role in the Courses Group

The courses group, arranges a group of different courses with some relationship or purpose systematically, which is a group of courses supporting the level-two project on the branch of the personnel training scheme fishbone diagram, as showed in the figure 2. All the courses in the same courses group support the same level-two project, so the level-three projects of the courses relate with others in the contents and the trainings. The level-three projects are the parts of the corresponding level-two projects after the proper extending and improvement. All the level-three projects in the same courses group support the same level-two project. It turns out, from the view of the courses group, the level-three projects connect the different courses.

### C. Role in the Course

The teaching focuses on the professionals training and supports the professional abilities' training. In the course, the level-three projects should guide all the level-four projects and key points of the course, as showed in figure 3. The level-three project supports the training object of the course and corresponds to the abilities of the course directly, which is the main thread of the course.

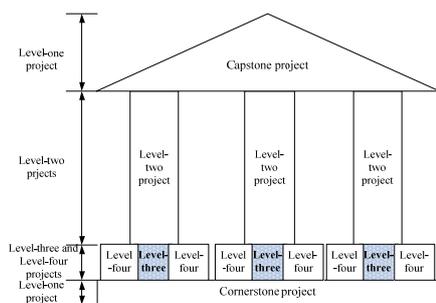


Figure1. TOPCARES-CDIO personnel training scheme structure diagram.

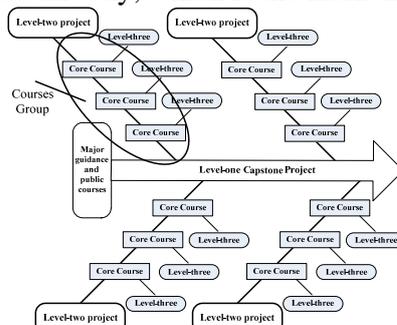


Figure2. The courses group of the fishbone diagram of the personnel training scheme.

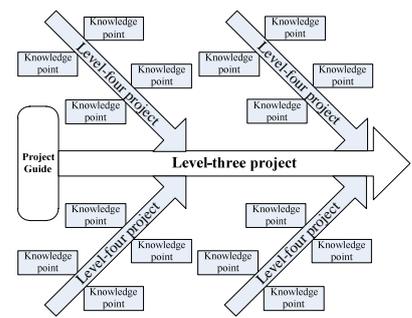


Figure3. The fishbone diagram of a course.

It turns out, the level-three projects, at the different positions in training scheme, courses group and course, play roles of the foundation, the connection and the main thread, which shows the level-three projects are very important.

## Design of Level-three Projects

As the level-three project has a relationship with the level-one and level-two project very closely, the design of the level-three should be considered from different views. The main principles of the design of the level-three project are: using the familiar services as background of the project; the purpose closely interrelating with the training scheme, level-one project, level-two project and the courses group; some relative independence.

### A. Design from the View of the Training Scheme

In the training scheme, the design of the level-one project relates to the training object of the subject, and the level-two projects and the level-three projects are the abilities needed by the level-one project, so the top-down design method will be used in the design of the level-three project. For example, the training object of the computer science and technology specialty is the ability of the design and development of the software and hardware, and the related level-one project will be performed in the first term of the fourth year, which trains the hardware design abilities of the students, and the final object of which asks the students to develop the software on the PCB made by themselves. As showed

in the table 1, the level-three project of the major course “principle of single-chip computer and its application” opened in the second term of the third year asks the students to master the knowledge of the PCB. The project closely relates with two level-two projects respectively opened in the third term of the second year (Practice Term) and the third term of the third year (Practice Term).

Table1. The Hardware Ability Training Table.

Project Level	Opening term	Project(Course)	Ability
Level-one Project	The first term of the fourth year	Embedded System Project Development	Developing PCB
Level-two Project	The third term of the third year	Embedded System Project Practice	Designing PCB
Major course (Level-three Project)	The second term of the third year	Principle of Single-Chip Computer and Its Application	Using PCB
Level-two Project	The third term of the second year	Digital Circuit Practice	Understanding PCB

#### B. Design from the View of the Level-two Project

The level-three projects in the course are closely related with the adjacent level-two project, so the related level-two project can be taken into account during the design of the level-three projects. For example, the level-one project, “the developing of the virtual ATM coffee machine” of the software engineering, is divided into three parts: the “developing of the coffee ATM”, the “remote control client” and the “Web management system”, which are respectively performed in the level-two projects opened in the third term (Practice Term) of the first, second and third year, showed in table 2.

Table2. The Division Table of Level-one Project.

Level-one project		Level-two project	
Name	Implement Term	Name	Implement Term
The development of the virtual ATM coffee machine	The first term of the fourth year	The development of the coffee ATM	The third term of the first year
		The remote control client	The third term of the second year
		Web management system	The third term of the third year

The level-two project of the third term of the first year asks to design a coffee ATM. Through the project, the students should master seven abilities: the control system of the state machine, the object-oriented system, event-driven system, and GUI operation interface, cooperative programming between JAVA and C, I/O operation of the local data file, and making the exe file. The level-three projects, in the major course “UML and the object-oriented system design” of the second term of the first year of the specialty, involve the first four abilities, so the level-two project is the extending and improvement of the level-three projects.

#### C. Design from the View of the Courses Group

The courses in the same courses group support the level-two project opened in this year, so they should related the level-three projects. For example, as showed in table 3, the computer science and technology specialty, for training the ability of software development, respectively opens four major courses in the first year and second year, which use the same level-three project the “student's grade management system”, with the same background, but different focus of the technologies, that makes the students be more clear about the requirement of the project and more rapidly introduced into the project, and saves time. From a point of view, the courses using the same project will be harder step by step, which corresponds with the improvement of the abilities of the students; from another point of view, expanding the level-three projects of the two related courses in the same year and changing the background to form the level-two project of this year, can improve the abilities.

Table3. The Relationship of the Level-three Projects in the Courses Group.

The level-three project	The major course/Opening term	Techniques Emphasis	The level-two project/Opening term
The student's grade management system	High Level Programming Basic (C)/The first term of the first year	Process-oriented, implemented by array	Library Management System /The third term of the first year
	Data structure (C)/The second term of the first year	Process-oriented, implemented by link-list	
	High Level Programming (JAVA) /The second term of the first year	Object-oriented, implement the foreground	Football League Management System /The third term of the second year
	Database Principles and Applications /The second term of the second year	The design and implement of the background	

Under the main principle, the variety of the design should be advocated, and the final object is to design more reasonable level-three projects to improve the ability of student.

### Implementation of Level-three Projects

In the building of the level-three projects, to carry out is the most important point, while the other two: design and implement, are also important.

Related to the implement, there are three ways of the implement of the level-three project: in the course, out of the course, in and out of the course. To the lower-grade student (professional basic course), because they lack the related knowledge and experience, the teachers will guide them to finish the projects, add some projects out of the course based on the projects in course, and encourage the students to finish the projects out of course by imitating the project in course and to improve the projects. To the higher-grade students (professional course), because the students have some basic knowledge, the teachers should encourage the students to finish the project out of course. For example, the teacher gives a project and the requirement in course, and encourages the students to choose the background freely and to improve the project.

When implementing the level-three project in course, and there is only one level-three project, the teachers can implement the project by the ways below:

#### A. Integrated

As showed in figure 4, the integrated way is an ideal implement way of the level-three project. Using a level-three project throughout the course and connecting all the knowledge are the real work-integrated learning implement way of project-guide and "learning in the work". This way is suitable for the practice course of software usage, such as "Web Design and Construction"<sup>[3]</sup>.

#### B. Centralized

The centralized way is showed as figure 5. This way approaches every knowledge unit after the project guide, and implements the level-three project at last. This way is similar with traditional course design, while the difference is that this way focuses on the training of the abilities, not only an implement of the course design. This way is more suitable for the heavier courses, such as "Circuit Theory" and "Principle of Computer Organization"<sup>[4]</sup>.

#### C. Distributed

The distributed way is the combination of the integrated way and centralized way, as showed in figure 6, and the P1 to PN respectively represent the every part of the level-three project. The implement way approaches the every knowledge unit after the project guide, the related parts of the level-three project will be finished after the knowledge unit is finished, and the implement of the level-three project will be finished after the knowledge units of the course are finished, which asks the

careful constructions of the order of the every knowledge unit of the course and the relationship of the knowledge unit. This way is suitable for the programming course, such as “High Level Programming Basic (C)”<sup>[5]</sup> and “High Level Programming (JAVA)”<sup>[6]</sup>.

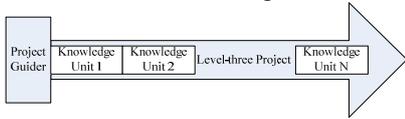


Figure4. The integrated way of the implement of the level-three project.

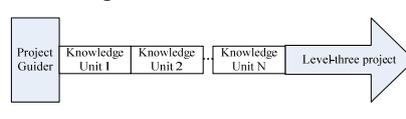


Figure5. The centralized way of the implement of the level-three project.

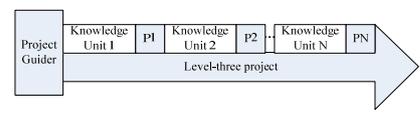


Figure6. The distributed way of the implement of the level-three project.

If there are more than two level-three projects, the ways above can be used together, which depends on the nature and content of the course, to make the best use of the level-three project.

## Conclusion

The level-three project is an important role of training the abilities of students. To achieve the objects, the careful constructions should be performed from the design to the implement. The design of the level-three project considers not only the relationship among the training scheme, courses group and courses, but also the independence of the three. The implement of the projects should depend on the real cases of every course. The implement of the level-three projects directly affect the implement of the TOPCARES-CDIO teaching reformation. The more we explore in practice, the better implement way of the level-three project we get.

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