Abstract—Economic progress and information technology development have spurred the demand of multi-talents. So cultivating the compound talents with computer application ability is one of the main duties for the Subject Construction of Opto-electronics Engineering. According to this, the hierarchical curriculum system of the computer application education for opto-electronics engineering undergraduates is briefly introduced. The problem of how to strengthen training of integrated capability especially the computer application skills of students through graduation design is expatiated emphatically. Taking an example of the graduation design based on LabVIEW, which is such an icon-based graphical programming language that allows engineers to express their ideas in a more intuitive and natural way, the following means are explained: enhancing the capability of problem analysis in starting phase; training of solving problem independently in execution phase; cultivating the ability of induction and summarization in the thesis writing period. The practices show that the above strategies can help students to improve multi-aspect capability and to meet the requirements of society better.

Index Terms—graduation design, integrated capability training, computer application education, Opto-electronics Engineering specialty, LabVIEW

I. INTRODUCTION

Computers have developed into the main platform and key means for science and technology research in our current information age. As an important discipline in science and technology of information field, opto-electronics engineering specialty has a clear educational objective. That is to enable the graduates to have abilities to engage in research, design, development and management in the opto-electronics information fields, such as detection and analyzing of signals, signal processing and storage, and so on. Therefore, it reflects the great demand on high-quality opto-electronics engineering (OE) talents in the information society as well as realizes the task and objective of computer application education that we cultivate the students to be the compound talents with both proficient professional principles about opto-electronics information and the computer application skills for the OE specialty in universities and colleges.

II. HIERARCHICAL COMPUTER APPLICATION EDUCATION FOR OPTO-ELECTRONICS ENGINEERING UNDERGRADUATES

So far as public know that in 21st century, the computer education will be far from narrow-sense traditional computer technology education, but is nonetheless one that has risen to be the information education. Considering the Opto-electronics Engineering is a multi-interdisciplinary subject intersected by optics, mechanics, electronics and computer science, we regard the computer education oriented by professional application as a system engineering during the undergraduate program of OE specialty in the School of Instrumentation Science and Opto-electronics Engineering, Beijing University of Aeronautics and Astronautics. The computer education system is organized as three levels and three stages with the curriculum approach acted in a “1+X+Y” manner, which is shown in Tab. 1. Moreover, the computer application ability is especially emphasized to solve practical problems in professional fields through the whole process of teaching.

In the third level of the computer application education, the graduation design, an important stage for the training of talented personnel with the comprehensive quality and the ability of engineering practice, is both the key link of effectively training students to solve practical problems in professional fields with computer technology and the “warm-up” step for the students before they go to take up real posts. It should be attached importance by reason that one of its function serves as a bridge between university and society. An example is presented in this paper to expound how to make a student experience a storm-based learning to accept new knowledge, carry out the task by requirement analysis, general design of software and realization of programming in the graduation project, and further strengthen the computer skills as well as improve comprehensive quality.
TABLE I. HIERARCHICAL CURRICULUM SYSTEM OF THE COMPUTER APPLICATION EDUCATION

<table>
<thead>
<tr>
<th>Teaching arrangement</th>
<th>Level I Compulsory 1 subject</th>
<th>Level II Compulsory X subjects according to the professional direction</th>
<th>Level III Optional Y subjects elective for further training</th>
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<tr>
<td>Teaching objectives and stages</td>
<td>To make students get the basic understanding to the information society and the information technology in the first year in college.</td>
<td>To make students master the basic knowledge of computer hardware and software, the basic programming language and programming method and the ability to solve elementary practical problems in professional fields in second and third years in college.</td>
<td>To cultivate students’ innovative spirit and computer application skills to solve practical problems in professional fields in following stages, such as case teaching, comprehensive experiments, course design and graduation design.</td>
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III. PRACTICE IN GRADUATION DESIGN WITH THE PROFESSIONAL FEATURES

Graduation design usually includes three stages. They are respectively starting phase (determining the subject and the project plan), medium-term inspection (adjusting the project schedule and the degree of difficulty) and graduation these defense (summarizing and reporting the graduation project). Subject of choice by the project tutor is a key link in graduation design. It constitutes the prerequisite and the guarantee for a high quality implementation. When take account of putting the computer application education into graduation design practice, we usually determine the theses subjects for OE majors based on the following two principles: (1) the principle of complementary between teaching and scientific research. Subjects should come from engineering practice or scientific research projects with application properties as much as possible. For a theoretical work, we should divide it into one or more scenarios converted into the theoretical validation work; (2) the principle of plural development and medium difficulty. Subjects should reflect the feature that OE is related to many different domains, such as optical, mechanism, electro-circuit and micro-computer. And they should be ensured that the students could complete their tasks on time after efforts.

A. Starting Phase Period: Cultivating Ability of Analyzing the Subject

Based on the above principles, the subject of “Design of Man-machine Interface and Data Communication on Virtual Multi-channel Temperature Measurement Instrument”, whose essential content is implementation of upper layer application software for the instrument control system, is distilled from the scientific research project “Study on Key Technologies of Interventional Medical Fiber Temperature Sensing System”. This subject not only reflects the OE specialized features with information measurement and processing but also embodies completely the deep integration of computer technology and instrument technology. Moreover, it gives a show that how the virtual instrument technology\(^1\) is applied in the OE field. Communication and exchange of data between the equipment and the computer, analysis and processing of the measured data as well as output and display of the processing results. Under the tutor’s guidance, the student carried out the general design of the software according to the above functions, including making a choice of the software platform and designing the software architecture. It can be learned from literatures that there are two kinds of software development platforms for virtual instruments: (1) Textual programming language\(^5\): visual C++, Visual Basic, LabWindows CVI, and so on; (2) Graphical programming language\(^6\): LabVIEW, HPVEE, and so on. Among them, LabVIEW, which stands for Laboratory Virtual Instruments Engineering Workbench, is a Graphical Programming Language first released by National Instruments, with intelligible user interface construction\(^7\) and dataflow programming concept\(^8\). It was created to help scientists and engineers design automatic measurement instruments with the idea of “The software is the instrument”. And it has matured to become a general purpose and popular programming environment at present. Therefore, the student ultimately chose LabVIEW as the software platform and put forward the software architecture shown in Fig. 1, in which main functions were divided into specific modules. By way of doing this, the student was trained to analyze problem independently and the content and emphases of the subject were made clear. The technical route for the graduation design is finally determined, so the student could rapidly begin concrete programming.

B. Implementation Period: Cultivating Ability of Solving Problems Independently

Programs in LabVIEW are called VIs (virtual instruments). Each VI consists of two main components: a front panel and a block diagram. So the student’s assignment was composed of two parts: designing front panels and constructing block diagrams.

1) Design of Front Panels and User Interface Model.

The front panel can simulate the panel of a physical instrument\(^9\). It is the interactive environment of a VI. It is used for operations and display of the processing results. Under the tutor’s enlightening guidance and based on analysis of system functions during the starting phase period, the student designed
The user interface should be integrated, friendly and easy to operate. If it had been designed based on monolithic interface model which was most similar to the panel of a physical instrument, it would be easy to operate but miscellaneous when there were many subfunction modules. Thereupon, the student designed the user interface using dynamic invocation and the modular design method adopted in computer software engineering. In this way, sub-panel corresponding to a module shown in the third layer of Fig. 1 is dynamically loaded into memory iff it is called, which achieves time-sharing reuse of the interface. It ensures an attractive and structured user interface. Meanwhile, it both reduces complexity of programming and improves the operation efficiency of the computer program. The front panels while data communication and mathematical analysis are in progress are shown in Figs. 2 and 3, respectively.

2) Construction of the Block Diagrams
The execution of each VI is governed by the structure of the block diagram corresponding to its front panel. A block diagram is a source code of a VI that is constructed in G language. It is the actual executable program. Block diagrams are constructed by terminals, nodes, structures and wires. The data from the controls or to the indicators on the front panel of a VI are transferred between terminals. Functions are called by nodes. Structures such as While Loops and For Loops represent different structural control commands. Wires can be regarded as data flows generated in the execution of the program. In this graduation design, the main assignment is to construct block diagrams in detail by choosing correct nodes and arranging data flows reasonably to realize function of each module.

3) Implementation of Data Communication
The student made full use of the basic knowledge of computer hardware and software to independently develop I/O interface programs in LabVIEW, implementing serial and USB communication with VISA (virtual instrument software architecture). Developing programs with VISA, the student has recognized it is the standard I/O application program interface applied in programming for the programmable instrument[11]. So using almost the same way adopted in traditional I/O programming, the student implemented data communication with equipments mainly by read-write operation and attributive control on equipment ports.

As known to all, virtual instrument system in which equipments and PC are connected through serial bus has the advantages of convenient operation and simple interface. For the computer standard serial port[12], a group of sub-VIs is provided by LabVIEW for serial communication based on NI-VISA. They are VISA Configure Serial Port, VISA Read, VISA Write, Serial Settings: Number of Bytes at a Serial Port and VISA Close. Correctly configuring and wiring these sub-VIs, the student constructed the block diagram shown in Fig. 4 for serial communication. The interface after the software converted format of received sinusoidal data sent by the serial port debug assistant is shown in Fig. 2.

It is more difficult to construct the block diagram for USB communication. The student learnt relevant knowledge of USB protocol and designing USB interface system in LabVIEW by various ways including literatures and network resources. Finally, he adopted the currently common design mode of uniting special USB interface chip with MCU (microprogrammed control unit). First, the USB device was configured by INF file in VISA Driver Development Wizard. Then, the special chip ISP1582 in the USB interface system...
was read, written and controlled by VISA Read, VISA Write and VI Property in LabVIEW. According to the USB protocol, the student sent commands to MCU in interrupt transfer mode while received data in bulk transfer mode. The block diagram for USB communication is shown in Fig. 5.

For realizing data and analysis results sharing, it requires the local system transmit measured data and measurement reports to another PC. Therefore, the student learnt relevant knowledge of TCP/IP protocols and used sub-VIs defined in LabVIEW for TCP transport to construct client and server diagrams[13] respectively shown in Figs. 6 and 7. Waveform data or reports are sent by TCP Write at server side and received by TCP Read at client side. After accomplishing the transmission, the client and the server are disconnected. The interface while the client is running on the peripheral computer to receive data and files is presented in Fig. 8.

4) Implementation of Data Processing

As illustrated by Fig. 1, data processing, one of main system functions, consists of data storage, data playback, mathematical analysis and report printing. While the student was developing these program modules, the tutor pointed out that mixed programming could make full use of variety of reliable and efficient algorithms provided in MATLAB and advantages of LabVIEW’s visual representation. It made the student understand that comprehensive application of different software development platforms is beneficial to enhance software functions. Thus, when developing mathematical analysis module, the student controlled MATLAB by DIMAPP ActiveX in Matlab Application Type Library provided by MATLAB. With the benefit of mixed programming with LabVIEW and MATLAB[14], probability distribution of measured data was obtained. Fig. 9 shows the block diagram for realizing this function. The probability distribution is shown in the XY graph in Fig. 3.
C. Thesis Writing Period: Cultivating Ability of induction and summarization

From the software engineering side, computer software is the union of computer programs and software documents. In the graduation designs for OE majors, the training of writing software documents will be performed in the thesis writing period. Generally, writing theses about application of computer technology to solve problems in the professional fields, students should explain clearly the thread of “why to do”, “how to do” and “how the effect is” through their comprehension and technical implementation of the graduation projects. Furthermore, the background knowledge as well as general introduction and some concrete details of related technologies should also be included in the thesis. These requirements can effectively goad students to improve their ability of comprehensive thinking as well as induction and summarization.
IV. CONCLUSION

With an increasing demand for high-quality comprehensive talents in today’s society, strengthening computer application education for opto-electronics engineering majors by programming practice in graduation design seems increasingly important. It can spur students to get a deeper understanding of the OE characteristic related to optics, mechanics, electronics and computer science in the project by means of their comprehensive application of the various knowledge they learned in previous. At the same time, programming can both train students’ close reasoning capability and activate students’ imagination. Besides, it can also enhance students’ practical competence of scientific research. In a word, the cultivation process of the graduation project and the hierarchical curriculum system of the computer application education described above will have a profound effect on students’ future study and work.

REFERENCES


