Experiment Teaching Reform of Principle of Computer Composition

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Abstract—Experiment teaching content of Principle of Computer Composition is complicated and abstract, mixing with a lot of specious concept. It is difficult for students to master the operating mechanism of a real computer system. This paper expounds how to combine the project to improve their experiment teaching, and ensure the students really develop an actual computer system. Such experiments can greatly improve the students’ practical ability and obtain more profound understanding of the CPU structure.

Keywords—principles of computer composition; experiment reform; experiment teaching; project teaching method

I. INTRODUCTION

Principle of computer composition is a core course, which forms a connecting link between the preceding and following courses in computer major. Because the course content is complex, and mix with a lot of specious concept, it can only be combined with the actual project to understand how a computer system works, and grasp the key and difficult points of this course[1].

"Experiment teaching of Principle of computer composition" is an experiment course for computer science and technology in the beginning, the experiment box of computer constitution principle was used to carry out the experiment, through the testing and operation over the past few years, there are many disadvantages in the experiment box:

- The experimental method is out of line with the prior hardware course. There has been a close link between the hardware courses, due to different courses use different experiment boxes, it is difficult to establish contact among courses, and exists the serious phenomenon of theory’s separation from practice.
- The hardware structure of the experiment box is fixed, the main work of the students is only to plug in the wiring between the corresponding hardware modules, so the experiments are mostly confirmatory experiments, students can't design modules themselves, all experiments are difficult to break through the limitations of the experiment box.
- The number of experiment boxes is difficult to satisfy the students' increasing needs, and laboratory hardware investment is relatively large, so the number of experiment boxes was inadequate without sufficient funds.
- Because of the particularity of the experiment boxes, the whole experiment box is scrapped in the event of a system failure; it’s difficult to maintain laboratory equipment and apparatus.

To this end, we introduced EDA technology in the "Experiment teaching of Principle of computer composition", The experiment can complete the function design, logic design, performance analysis and function test by computer simulation. Finally, a tutorial file is generated to guide further experiments. Through the application practice in recent years, we used computer simulation software QUARTUS to design the CPU machine; Then, computer simulation software MODELSIM is used to show simulation results. Through such experiments, the students' practical ability is greatly improved, and more profound understand of the CPU structure[2].

II. CURRICULUM PLANNING

In order to really understand the composition of a computer system and its internal operating mechanism, students are required to complete the design and debugging
of a computer system (model machine) in an experimental
course. However, it is difficult to achieve this goal, mainly
due to the lack of the basic level and practical experience of
students, they can't understand CPU architecture. In order
to develop an effective "design method" as a guide to achieve
the teaching purpose, several key points are considered:

- On the basis of the basic concepts of textbooks, we
  begin to learn the CPU Design from the underlying
  hardware.

- Designing the underlying module through computer
  simulation software QUARTUS, such as register
  module, operation module design, sequential circuits,
  controller design, in this way, students not only
  mastered the basic design of hardware module, but
  also have an intimate knowledge of the hardware
  description language.

- Students are required to design the instruction set,
  including instruction format design specification, the
  description of each instruction and functional
  components involved, understanding of CISC / RISC
  instruction system (the relationship between
  assembly and machine code).

- Design of algorithm state machine. Design some
  projects; transform questions in natural language into
  the sequence flow chart which can be processed by
  computers.

- As long as the sequence flow chart once formed, it's
  easy to obtain state function and the output function,
  accordingly, the corresponding hardware circuit is
  obtained.

- System simulation design. Through the computer
  simulation software MODELSIM to design the
  system simulation, through software debugging to
  ensure that the whole system can be logically
  realized, It also provides the basis for following
  hardware debugging.

III. PROJECT FORMULATION

A. Basic principles of project formulation

The most basic and the most critical problem of Project
Teaching method is project formulation, quality of "project"
has a direct impact on the teaching effect, so it's necessary
to establish some basic principles of project formulation.
Through practice, we believe that the following principles
can guide the formulation of the project:

- The project formulation should be based on the
  teaching objectives, contents and features of the
course "principles of computer composition". The
  experiment content should take the teaching content
  as the core; It is to make the students solve the
  problem combining with the teaching content.

- Degree of the project difficulty. The limited time for
  the course severely affect the project difficulty, and
  too simple items will affect students' learning
  initiative, so we should consider the students' ability
  and class restrictions when we design a project.

- Because of restrictions of experimental conditions,
  it's necessary to sure students can design and
  implement the project.

B. Project and contents

According to practical experience, we consider that the
project should include the name of the project, content and
requirements. And the number of items should be as large as
possible, so that students can choose according to their
personal interests. As for the project, we give some
examples[3]:

- Fixed-point arithmetic unit: Designing a 16 bit
  fixed-point arithmetic unit, which can add, subtract,
multiply and divide operations of 16 bit binary
  numbers, and can work in two states of offline/online.

- Sequence generator: designing a sequence generator
  which can produces 6 beat pulses T0-T6.

- Counter: Designing a 16bit counter, which can
  realize loop counting function.

- Microprogram controller: Based on the existing
  teaching machine instruction system, adding 8-10
  new instructions, including defining instruction
  formats and functions. Then debugging the new
  instruction correctly and add it to the teaching
  computer hardware system.

Take Microprogram controller for example:

<table>
<thead>
<tr>
<th>TABLE I. SINGLE BYTE INSTRUCTION</th>
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</thead>
<tbody>
<tr>
<td>Opcode 4bits</td>
</tr>
<tr>
<td>0000</td>
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<tr>
<td>0001</td>
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<tr>
<td>0010</td>
</tr>
<tr>
<td>0011</td>
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<tr>
<td>0100</td>
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<tr>
<td>0101</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>TABLE II. DOUBLE BYTE INSTRUCTION</th>
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</thead>
<tbody>
<tr>
<td>Opcode 4bits</td>
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<tr>
<td>0010</td>
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</table>

I) Instruction set

The CPU model has 13 instructions, the 0-9 instruction
is a single byte instruction, and the 10-13 instruction is a
double byte command.

<table>
<thead>
<tr>
<th>TABLE III. INSTRUCTION SET</th>
</tr>
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<tbody>
<tr>
<td>Serial</td>
</tr>
<tr>
<td>0</td>
</tr>
<tr>
<td>1</td>
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<tr>
<td>2</td>
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<td>3</td>
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</tr>
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<td>5</td>
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<tr>
<td>6</td>
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</tbody>
</table>
### IV. Conclusion

Through the practice of "project teaching method", the following beneficial experiences are obtained:

- From the formulation and implementation of the project to the evaluation of the project completion, students are involved in it and fully reflect the students' learning initiative. And in the process, it also improves the students' enthusiasm and efficiency in learning the principles of computer composition.

- After adopting this teaching method, students arrange the experiment time and content independently according to their individual time, and students' design and experimental ability has been effectively improved.

- Through the practice of the course, the method, content and practical experiences of “project teaching method” are accumulated, which lays a foundation for other courses.

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### REFERENCES


