

Exercise Design for Introductory Programming

“Learn-by-doing” basic OO-concepts using Inverted Curriculum

PROJECT PLAN

Master Thesis

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Marcel Kessler

9-th semester

kesslema@student.ethz.ch

Supervising assistant: Michela Pedroni

Supervising professor: Bertrand Meyer

1. PROJECT DESCRIPTION

Overview

In Winter 2003/2004, a new introductory course on programming was introduced at the ETH Zurich [1]. A new approach, called Inverted Curriculum, was used for the first time. In this approach, students step-by-step grow from consumers to producers of a library (called “TRAFFIC”) especially designed for this purpose. That is why Inverted Curriculum is also known as „progressive opening of black boxes“ or the „outside-in method“.

Exercises were designed in a way that first the students’ application just uses the components of the library (the “black boxes”), and later the students gradually plunge deeper into the library code by requesting modification and extensions of the library code. This way, the students should appreciate the benefits of abstraction, reuse and a good object-oriented framework right from the start.

After a first mostly successful test on the students, the especially designed library TRAFFIC and the exercises belonging to it are to be redesigned and improved, to get even closer to the goal of having a perfect library that can be used and extended as intended in the Inverted Curriculum.

Scope of the work

The master thesis is composed of 5 parts:

- Background: Getting used to TRAFFIC and the “Introduction to Programming” course
- Theory/Reading: Criteria and general rules for designing educational meaningful exercises in computer science introduction
- Framework: Form (goals, difficulty (mastery concept), hints, Lernaufgaben [2] etc.) and method of access to the exercises (and the master solutions) and the final project

- Exercises: Evaluating the “old” exercises, designing new exercises and proper master solutions, designing additional exercises (for exam preparation)
- TRAFFIC: Playing a part in the redesign of TRAFFIC (additional needs for new exercises) and integrating the exercises into the TRAFFIC software

Intended results

- Report: A documentation of all the work that was performed during the thesis
- Practical work: The appropriate exercises and solutions (integrated in TRAFFIC)

Personal motivation

I had almost decided on another diploma thesis when I heard about this topic, and after giving it some thought it was clear for me that I had to switch to this thesis. One reason for this was that I am doing “education” as my minor subject and that I am very much interested in teaching and didactics. The other reason was that I will have the chance to design exercises that will be used by several hundred students and might therefore have some (hopefully positive) impact on some human beings instead of disappearing somewhere deep down in a drawer.

2. BACKGROUND MATERIAL

Reading list

[1] Michael Kölling. The Design of an object-oriented environment and language for teaching. Basser department of computer science, university of Sydney, 1999.

[2] Angela Carbone, John Hurst, Ian Mitchell, and Dick Gunstone. Principles for designing programming exercises to minimise poor learning behaviours in students. In Proceedings of the Australasian Conference on Computing Education, pages 26–33. ACM, 2000.

[3] Angela Carbone, John Hurst, Ian Mitchell, and Dick Gunstone. Characteristics of programming exercises that lead to poor learning tendencies: Part ii. In Proceedings of the 6th Annual Conference on Innovation and Technology in Computer Science Education, pages 93–96. ACM, 2001.

[4] Donald Clark. Bloom’s taxonomy. Online, June 2003. <http://www.nwlink.com/donclark/hrd/bloom.html>.

[5] Tony Jenkins and John Davy. Dealing with diversity in introductory programming. In 8th Annual Conference on the Teaching of Computing, Edinburgh, LTSN Centre for Information and Computer Science, 2000.

[6] Jens Kaasboll. Exploring didactic models for programming. Tapir, pages 195–203, 1998.

[7] Raymond Lister and John Leaney. Introductory programming, criterionreferencing, and bloom. In ACM SIGCSE 2003, February 19-23, 2003, Reno, Nevada, USA, 2003.

- [8] Bertrand Meyer. Object-Oriented Software Construction, SECOND EDITION. Prentice Hall PTR, 1997.
- [9] Bertrand Meyer. Software engineering in the academy. IEEE Computer, 43(5), May 2001.
- [10] Bertrand Meyer. The outside-in method of teaching introductory programming. Online, August 2003.
<http://www.inf.ethz.ch/meyer/publications/teaching/teaching-ispj.pdf>.
- [11] Bertrand Meyer. Towards an o-o curriculum. Online, May 2003.
http://archive.ei_el.com/doc/manuals/technology/curriculum/page.html.
- [12] Mark Guzdial and Elliot Soloway: Teaching the Nintendo Generation to Program, in Communications of the ACM, vol. 45, no. 4, April 2002, pages 17-21.

3. PROJECT MANAGEMENT

Objectives and priorities

1. Design useful exercises for the course “Introduction to Programming” to be held winter 2004
2. Adaptation of TRAFFIC to fit the new exercise needs
3. Supply additional exercise for self-study and exam preparation

Obviously, the first two priorities cannot be looked at independently, yet the main focus of this thesis is the exercises.

Criteria for success

1. The students are happy with the new exercises

4. PLAN WITH MILESTONES

Project steps

Project start: Thursday, March 4 2004

Theory read and documented: Tuesday, 23 March 2004

Problems of “first-try” evaluated: Friday, 26 March 2004

Decision on framework and integration into TRAFFIC: Tuesday, 30 March 2004

Prototype developed: Monday, 17 May 2004

Exercises and solutions designed: Tuesday, 6 June 2004

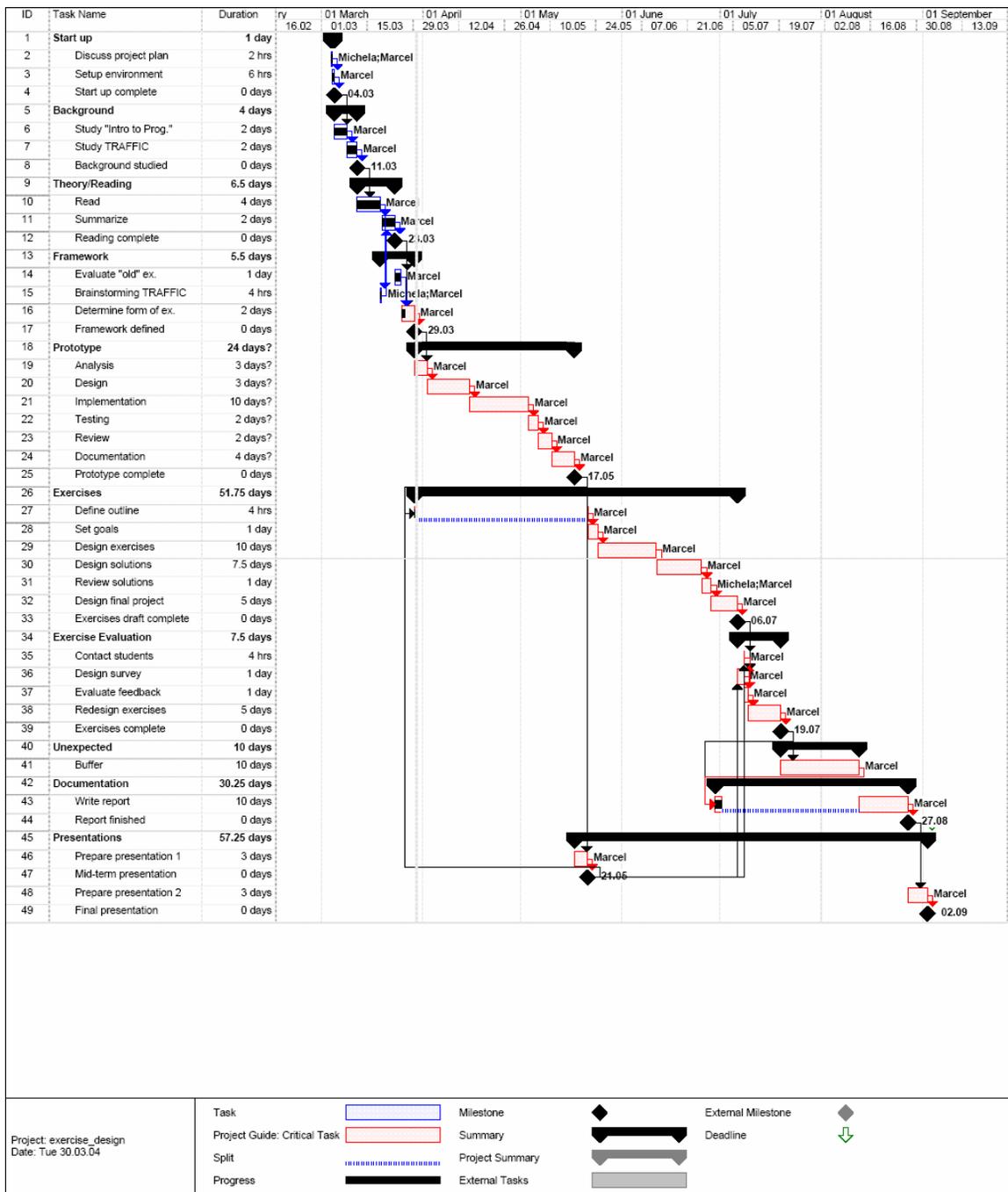
Exercises pre-tested on certain students: Monday, 19 July 2004

Report completed: Thursday, 2 September 2004

Deadline

Friday, September 3, 2004

Tentative schedule



REFERENCES

- [1] Chair of Software Engineering: *Semester-/Diplomarbeiten*; Online at: <http://se.inf.ethz.ch/projects/index.html>, consulted in January 2004.
- [2] Karl Frey: *Allgemeine Didaktik I*, ETH Zurich, 2002.