INSTRUCTION MODULE PROCESS CONTROL ENGINEERING

OVERVIEW

The instruction module Process Control Engineering discusses current topics for managing technical plants by means of an automated process control system. To this end, a process engineering laboratory consisting of two reactors and several tanks for raw materials and finished product are included. A cycle for the process system cleaning is also included for a realistic process application model.

STRUCTURE OF INDIVIDUAL CHAPTERS

All chapters of the instruction module follow the same basic pattern (Figure 1). After the ***Objective*** is introduced, first a ***Theory in Short*** is provided on which the Objective is based. Then, various aspects of the ***Theory*** are described in detail. An overview of the literature allows the participant to pursue the topic further on their own. Based on the ***Step by Step Instructions*** the reader is able to immediately put the theory into practice at the engineering station (ES) of the process control system. Each chapter concludes with ***Exercises*** that provide for additional practice to master the content of the respective chapter.

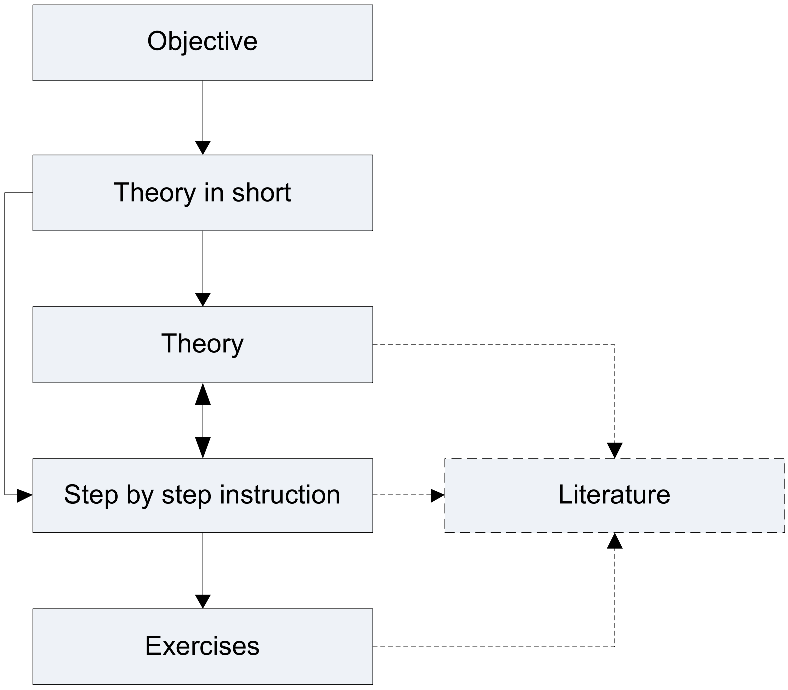

Figure 1: General Structure of Individual Chapters

HOW THE CHAPTERS RELATE

The sequence of the chapters is based on the sequence used when planning a process control system. Using the step by step instructions the student will complete the automation development for a sample process control system. However, all chapters and exercises can also be used as 'stand-alone'. All intermediate results attained in the course of the instruction module are available as project files which makes it possible to start/continue anywhere and to also compare one's own solutions with the sample solutions.

Instruction module P01:
Reading chapter ***P01-01 Process Description*** is recommended regardless of prior knowledge since here the process engineering plant to be automated is introduced.

In chapter ***P01-02 Hardware Configuration***, the structure of the automation system is set up. In steps 1 to 18 the configuration of automation components with STEP is trained.

Chapter ***P01-03 Plant Hierarchy*** introduces an essential PCS 7 structural element. Thus, automating complex plants can be broken down into smaller subtasks (refer to P01-04 to P01-06). In addition, the plant hierarchy provides a possible structure for visualization and serves as a basis for reusable elements and structural units (P02-03). By extension, the standardized execution of the plant hierarchy serves as a basis for recipe control.

Chapters ***P01-04*** to ***P01-07*** discuss the different aspects of basic automation

Chapter ***P01-04 Individual Drive Function*** introduces the utilization of existing software engineering objects (function blocks, templates) for real objects. As an example, controlling a pump motor with a function block of the PCS 7 Standard Library in a Continuous Function Chart (CFC). In this chapter, the result can be tested for the first time on a plant. If a plant is not available, the simulation that is introduced below can be used.

Chapter ***P01-05 Functional Safety*** discusses the interfacing of software-side interlocks for the for safety and control requirements of the plant. The previously implemented control of a motor is limited by given restrictions so that plant and people are not exposed to serious danger.

Chapter ***P01-06 Control Loop and More Control Functions*** deals with the topic Loop Control. Controlling the temperature of the reactor is used as an example to implement a PID controller.

Chapter ***P01-07 Sequential Function Charts*** discusses the SFC. It is used to implement the plant recipe. The exercise in this chapter concludes the first instruction module P01 and, as the first complex exercise, also includes contents from the previous chapters. The exercise examples in these chapters are set up in a way that they complete the engineering of the plant piece by piece. Nevertheless, each aspect can be learned individually by means of the available project files.

Instruction module P02:
Instruction Module P02 builds on the results of instruction module P01.

Chapter ***P02-01 HMI Generation*** discusses the configuration of a graphic user interface. Building on the results of the first instruction module, the system controls that have been configured so far are visualized through the PCS 7 Operator System (OS).

Chapter ***P02-02 Alarm Engineering*** deals with the implementation of a signaling system. Using the function block available in the PCS 7 library, tank level monitoring with a typical alarm strategy is implemented.
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Chapter ***P02-03 Importing Plant Design Data*** shows the design efficiencies of reusing individual control units and/or entire structural units.
This is demonstrated with the example of a CFC that is used as a template for generating additional CFCs. To work through this chapter requires extensive knowledge of the plant (P01-01) and its structure (P01-03).

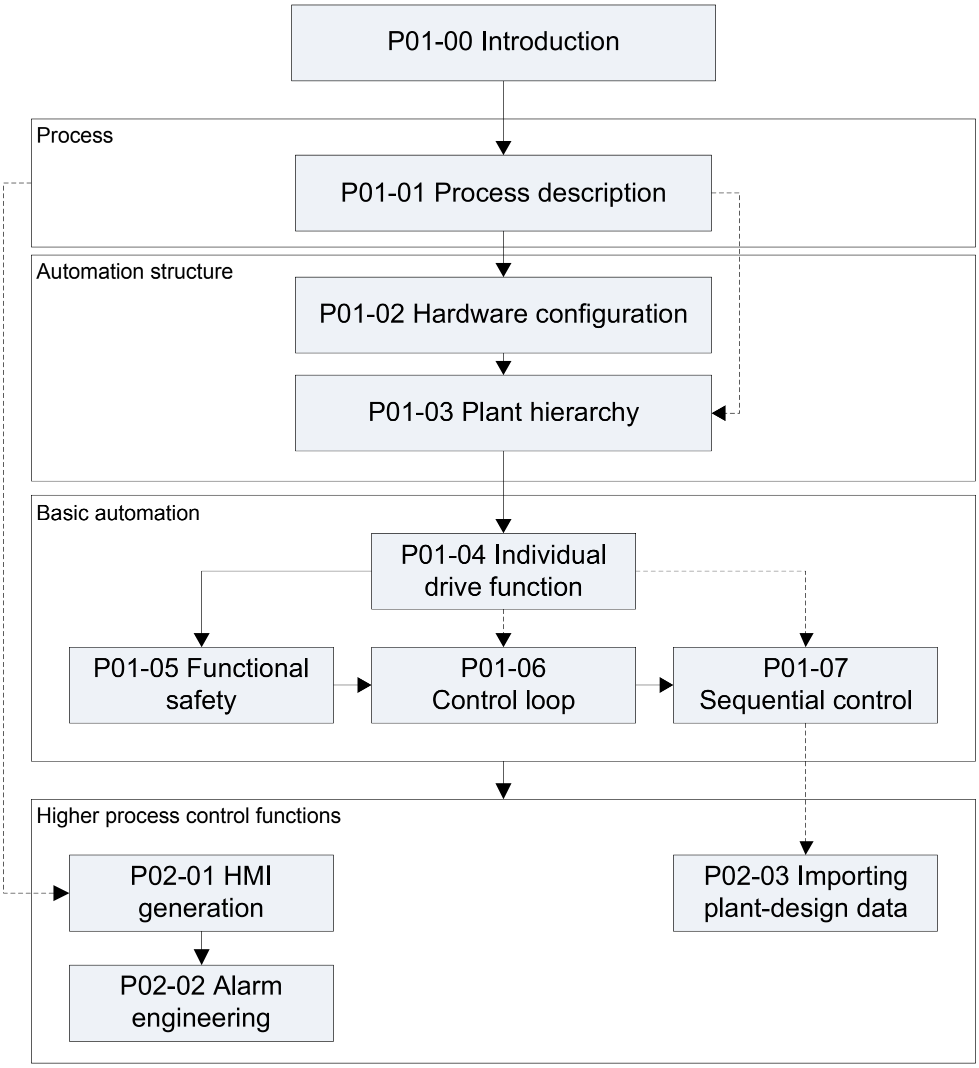

Figure 2: Pathways and Shortcuts through the Chapters

SIMULATION

To enable the student, without a plant or control engineering components, to start working immediately with the instruction module, an interactive simulation-supported learning environment was implemented for the instruction modules. It consists of the following components:

SIMIT Model: This model is used to simulate industrial engineering processes with tanks, pumps and valves, as well as encoders and actuators. The local operator panel of the plant is implemented in the model also.
It should be noted here that the model is to be used only for generating encoder and actuator signals. The indication should not be misunderstood as a visualization (OS) interface. For operator control and monitoring, The PCS 7 OS is used in the project.

SIMATIC PLCSIM: Here, the automation system is simulated. The scope of the functionality is configured mainly in instruction module P01. Changes within the automation system -regardless of hardware configuration or software (SFC, CFC)- are effective only after being reloaded to the simulation.

By combining the process model (SIMIT model) and controller model (PLCSIM) the entire system can be simulated and tested as shown in Figure 3.

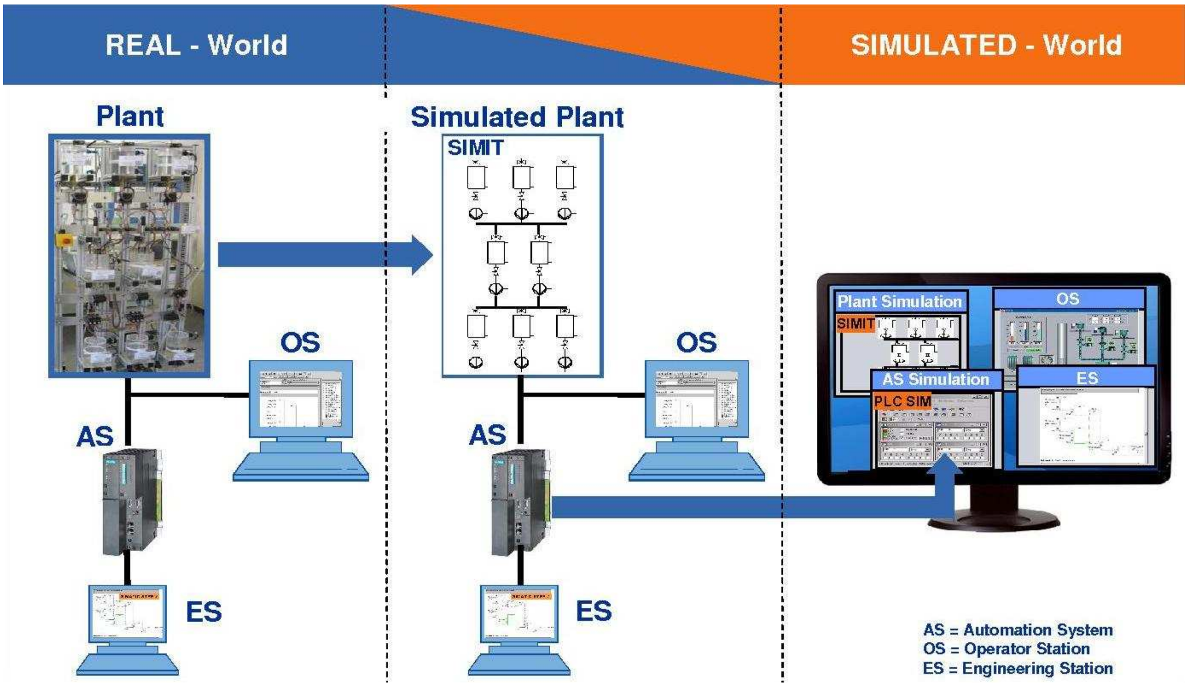

Figure 3: Analogies between Simulated Learning Environment and the Real World

SUMMARY:

The instruction modules P01 and P02 for Process Control Engineering provide sufficient learning resources, exercise material and references to an internship scope of 1-2 hours a semester week. Depending on the depth of topic penetration, 30 to 60 work hours have to be allotted (including exercises, homework, preparation and follow-up). This corresponds to 1 to 2 credit points within the scope of the European Credit Transfer and Accumulation Systems (ECTS).

HINTS FOR COMPACT TRAIN THE TRAINER WORKSHOPS:

PCS 7 train the trainer workshop for 5 days,
To introduce the lectures the instruction module Process Control Engineering (Chapters P01 and P02) incl. the lectures slides and to do practical training with the available learning resources, exercise material and references a 5 days workshop is necessary.

PCS 7 train the trainer workshop for 2 days:
For experienced instructors with knowledge of the software a 2 days workshop could be sufficient. The typical way is to work chronologically through chapters P01-01 to P01-04 including the exercises at the simulator and afterward to do one of the chapters P01-05 to P01-07, concluded with chapter P02-01.