Modelling of process control functionality in engineering education to improve problem analysis and design skills

The benefit of modelling skills in engineering is rarely examined, but in industrial practice extremely relevant for the quality of automation software, which is the background for this paper. In Germany modelling concepts are not fundamental in the curriculum of engineering education, but in US and UK they are fundamental basics. The effect of skills in modelling on the ability of problem analysis and synthesis should be examined in this work. The importance of these effects are widely discussed but not well examined up to now. Process engineers and process control engineers need to discuss the functionality of a plant. The same problem occurs between mechanical and electrical engineers. A "language" and a common mental model to communicate between these different skilled engineers is necessary, which is based on the requirements of the process itself. The quality of the notion is strongly depending on the adequate modelling concept for the process characteristics. The use of two specific concept (ICL and Unified Modeling Language) will be evaluated especially for education of process engineers. Software engineering in process control has many deficiencies in method, notation and tool support. As a result, the use of software engineering methods is not widespread in process control engineering practice. Nevertheless the consequences are immense regarding start-up times, additional costs and low software quality. One reason is the lack in training and in an adequate easy to use modelling language (concept). The paper will introduce a modelling language for
process control engineering regarding training. The proposal is to use ICL as a modelling concept for education of engineers to support their ability to specify software and communicate with software engineers. To evaluate the benefits of modelling concepts an experiment was designed and conducted with different groups of students of electrical engineering in their third year. As part of the lectures in process control engineering the two modelling concepts were introduced and trained. The students (mostly with a certificate of proficiency) should use this knowledge to analyse the functionality of a teaching model (sorting and stamping machine), model the functionality and after that prepare the program of this model in a specific programming language for process control engineering (IEC 61131-3). Three different groups with similar basic knowledge (tested with a questionnaire and pre-test) took part in the experiment: one group was not explicitly asked to use any modelling notion, the second group modelled the functionality in UML and the third group used ICL. To avoid distortion of the results the use of tools was not implemented. As parameters for the benefits the time needed was recorded and the faults in the programme were counted and a post-questionnaire was analysed. The results of the first experiment are shortly summarized: The lack in acceptance of the necessity to analyse the problem before and model the requirements with any notion rises significantly with the experience in the programming language (IEC 61131-3). ICL was very beneficial, but not regarded as a modelling notion, because it is very intuitive. The time consumption of the UML group was the highest, nevertheless it is rated the most standardized notion in industry. The experiment will be re-designed to avoid the weaknesses of the first experiment and repeated during the summer semester: The number of students will be increased and the pre-test will be more elaborated. The programming task will be more complex to support the need of a semi-formal problem analysis and support for the groups will be reduced. The results will be hopefully used to change the curriculum.

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