Dr. Andreas Jedlitschka
Dr. Ulrich Löwen

10

Overview of the SPES Evaluation Strategy

The purpose of this chapter is to introduce the application of the methodologies in the following application domains: automation, automotive, avionic, energy, and healthcare. It describes the evaluation strategy for the systematic evaluation of the SPES modeling framework and presents the process for selecting appropriate case studies, as well as the example phase model that allows a comparison of the case studies. It also explains the common underlying structure of the chapters in Part III of this book.

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10.1 SPES 2020 Evaluation Strategy

Motivation: systematically obtain information on the benefits of the SPES modeling framework

To assess the impact of a technology on certain objectives, such as the technology's inherent benefit or efficiency, systematic evaluations based on scientifically sound criteria have to be planned and conducted. An empirical approach provides the foundation for the ideal research process that allows a meaningful assessment of the results of the evaluation with respect to the objectives of the investigation. Empirical data illustrate the potential and progress associated with the use of the technology. The vision is to demonstrate the benefits of a technology to industry and research through empirically obtained quantitative statistical values and qualitative information.

Evaluation strategy in SPES 2020

The SPES modeling framework was piloted and evaluated in the application domains following a common evaluation strategy. The strategy comprises a set of objectives from research partners and application partners, as well as general methodological guidelines to support planning, conducting, and analyzing empirical studies. The systematic evaluation approach of the SPES modeling framework has its origins in [Chen and Rossi 1983] and uses empirical methods to obtain data to explain or explore phenomena and to derive suggestions for future developments.

Main evaluation device: case studies

The main device used for evaluation in the application domains was representative case studies. The case studies provided a common platform for evaluating the SPES modeling framework by focusing on different aspects of embedded system development. According to [Yin 2003], case studies are "… an empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident" (p. 13). Often, case studies have small sample sizes and do not allow for controlling confounding variables. Case studies as applied in the application domains are categorized as feasibility studies. The focus of most of the case studies was on evaluating whether the SPES modeling framework can be applied in the domain, whether the viewpoints are seamlessly integrated, whether the implemented tools supported the approach, and on identifying improvement potential. In several studies, the concept of semistructured feedback sessions was used to obtain feedback from the users. The results of a case study are specifically valid in the environment they were obtained from. Case studies must therefore be selected with special regard to the evaluation focus. Section 10.2

summarizes the selection process for the case studies in Chapters 11 through 15.

Supporting means for evaluation: experiments

Experiments were used as supportive means for the evaluation and were intended to measure and analyze the effect of systematic variations in the independent variable on the dependent variable. Often, an experiment included an experimental group (in which "treatment" was applied) and a control group (control/no treatment applied) to show the effect of the "treatment" between the groups, i.e., the effects of applying the SPES modeling framework ("treatment" in the sense of above) in a development setting was compared to the method currently used (no treatment) with regard to a certain quality focus. The aim of experiments is to provide statistically representative results that are valid for the population from which the sample is drawn. For further details on several experimental designs, we refer to [Shadish et al. 2002].

10.2 Selecting Appropriate Case Studies

Embedded systems in the various application domains have different focus areas and are subject to different development approaches. Therefore, it was necessary to select a number of representative case studies within each application domain that would accurately reflect the special features of the domain, as well as present a good example of the challenges that the individual application domains face during development. This was necessary to ensure meaningful results from the evaluation of the SPES modeling framework.

Agreeing on a development phase model

Due to the heterogeneous nature of embedded systems (cf. Chapter 1) and their development (cf. Chapter 2), an application domain-independent phase model of the development of embedded systems was established. This phase model consists of the following development phases:

- Product definition
- System definition (Requirements)
- System definition (Architecture)
- Device definition (Requirements)
- Device definition (Architecture)
- Software and Hardware development as well as other development disciplines
- Integration

These development phases are common in most application domains. On this basis, a fundamental understanding across application areas for a

universal, model-based development process of embedded systems was created, allowing for common conclusions about the SPES modeling framework from the evaluation activities in the individual application domains (see Chapters 11 through 15).

Matching phase model, evaluation goals, and case studies

In addition, challenges and/or evaluation goals of individual application domains were identified and case studies were defined in each application domain. Particular attention was paid to ensuring that the case studies adequately addressed the engineering challenges of the application domains (cf. Chapter 2). Fig. 10-1 shows the relation of the case studies identified and the respective development phases they pertain to.

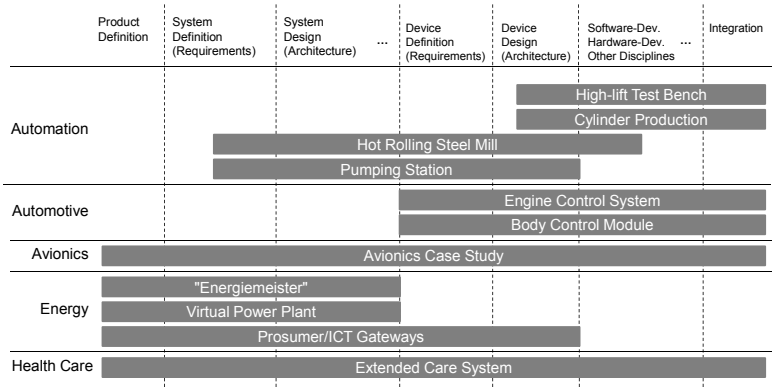

Fig. 10-1 *Classification of the SPES 2020 case studies in the development phases of embedded systems*

10.3 Structure of the Following Chapters

Chapters 11 through 15 focus on the use of the SPES modeling framework in the five application domains. To give the reader a better understanding and a simple cross-comparison between the domains, a uniform structuring concept consisting of five sections each was selected.

Section 1: Application domain overview

- The first section gives an overview of the application domain. In addition to providing a description, it also discusses the economic relevance, such as the proportion of the application domain in relation to the gross social product or details on added value. From a technical standpoint, the first section explains where embedded systems will be used today and in the future and the level of relevance they have. In addition to characteristics such as quantities and costs, it also explains life cycle requirements and general product and/or system properties. If any specific quality

considerations of the system under development (SUD) must be accounted for, e.g., safety properties, real-time response, reliability, or performance, the first section elaborates on these considerations. To conclude, the section discusses the particular problems of the application domain with regard to embedded systems.

- Section two of each chapter discusses the strategy used to evaluate the SPES modeling framework within the application domain. It unveils the central questions that had to be answered in the evaluation and explains how the problems described in the first section can be solved. This section also examines the procedure used for the evaluation and how the academic and industrial partners cooperated.

Section 2: Application domain-specific evaluation strategy

- The third section gives an overview of all evaluation activities, outlining the achieved results and integrating them into the SPES modeling framework.

Section 3: Evaluation activity summary

- A selective, but more in-depth discussion of a specific evaluation takes place in the fourth section. This section discusses the content-related objective and explains the specific activities and methods used in detail.

Section 4: In-depth discussion of selected activities and results

- Section five summarizes the results and answers the question as to what was achieved or not achieved within the scope of the evaluation. It presents suggestions for additional scientific work on the topic, along with the knowledge gained.

Section 5: Summary and conclusion

10.4 References

[Chen and Rossi 1983] H. T. Chen, P. H. Rossi: Evaluating with sense: The theory-driven approach. Evaluation Review, Vol. 7, No. 3, 1983, pp. 283-302.

[Shadish et al. 2002] W. R. Shadish, T. D. Cook, D. T. Campbell: Experimental and quasi-experimental design for generalized causal inference. Houghton-Mifflin, Boston, 2002.

[Yin 2003] R. K. Yin: Case study research. Design and methods. 3rd Edition, Sage, London, 2003.