Assignment 2, Research Planning Course

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1 The COSY project

1.1 Background

The automotive industry has in the last years witnessed a dramatically increase in the use of electrical and electronic components. In the premium segment 23% of the total manufacturing cost is related to the Electrical/Electronic (E/E) system and 80% of all new innovations stems from electronics [13]. The reasons for the large increase of electronics are partly to save cost. Expensive mechanical components can be replaced with cheaper electronic controllers. Also many of the new innovations demand the use of advanced electronics. Examples of these new systems are adaptive cruise control, blind spot detection, forward collision avoidance, lane departure warnings, and many more. Some parameters that makes it even harder to develop the E/E system is the assumed long operational life time and a complex supplier structure. At the same time many of the functionality controlled by electronics are safety critical and you can’t assume that regular maintenance is performed. Also many different variants with many different configurations exists partly due to different customer demands but also due to the legal requirements in the country the product is sold.

1.2 Partners and project goal

The research project is a joint project between industry and academia. Industrial partners are:

- Volvo Construction Equipment Components (VCEC) is a division that works as an internal supplier for Volvo Construction Equipment (VCE). VCE develops and manufactures wheel loaders, excavators, articulated haulers, graders, backhoe loaders and compact equipment. VCE is a part of the Volvo Group.

- Volvo 3P is responsible for product planning, product development, purchasing and product range management for the three truck brands that are owned by the Volvo Group (Mack Trucks, Renault Trucks and Volvo Trucks).

- Volvo Car Corporation (VCC) is a subsidiary of Ford Motor Company and manufactures cars in the premium segment.

Chalmers University of Technology and Mälardalen University are the academic partners in this project.
The aim of the project is to see what methods that are used in the early faces of development, regarding the Electrical/Electronic architecture, today in the automotive industry. Survey the benefits and drawbacks on these methods and also how well they connect to the business drivers. Use this information to develop methods and models that better support the systematic reasoning around the many uncertainties that exists in the early phases of development. Also a better understanding on how each phase in the life-cycle can be connected to the early phases and thereby increase traceability.

As a first step an extensive set of semi-formal interviews will be outlined to get an understanding on what the key factors are when taking E/E system design decisions. We are interested in technical decision factors as well as non-technical decisions factors.

1.3 Research method

There are a few different research methods that are planned to be used within this project. Most research approaches that are planned to be used are qualitative methods. Typical for qualitative research is that they aim to investigate and understand social and cultural phenomena in the context where they exist [9].

1.3.1 Semi-structured interviews

Semi-structured interviews is one of the research methods that will be used within this project. Semi-structured interviews has predetermined questions, but the order can vary based on the interviewers perception of what seems most appropriate [15]. Additional question can also be constructed during the interview and it is also possible to remove questions that seems inappropriate.

1.3.2 Case studies

Case studies is another method that is most likely to be used in the project. Case studies aims at looking into a project, active or finished, and in this case projects at the industrial partners will be used. Interviews are usually part of the case studies as well as looking at documentation for that particular case. To gain validity it is preferable to have multiple cases to base the conclusions upon.
2 Current research issues

For the automotive industry, and more specifically the E/E system, it is the handling of increasing complexity that are one of the main issues [14]. Also the introduction of more safety critical functionality is an issue repeatedly mentioned. How to predict cost and business values in the early phases of development is an issue discussed in [7]. A big standardization effort called the AUtomotive Open System ARchitecture (AUTOSAR) [2] is an initiative to standardize automotive software architecture and are supported by all major automotive manufacturers and supplier.

A few methods are available for E/E architecture evaluation that are subject to many papers in the area. One such method is the Architecture Tradeoff Analysis Method (ATAM) developed by Carnegie Mellon Software Engineering Institute. The goal of ATAM is to assess the consequences of architectural decisions in the light of quality attribute requirements [11]. Typically there exist competing quality attributes such as modifiability, security, reliability and maintainability that different stakeholders consider to be the most important. These quality attributes are broken down into scenarios. ATAM is divided into nine steps. These steps involve eliciting a utility tree and identifying risks, sensitivity and tradeoff points.

A more general decision support method is the Analytical Hierarchy Process (AHP). AHP is a multi-criteria decision making approach in which factors are arranged in a hierarchic structure [16]. In AHP all element are compared against each other which yield a robust result but also time consuming due to the large number of comparisons.

The Cost Benefit Analysis Method (CBAM) is an extension of the ATAM and is also developed by the Carnegie Mellon Software Engineering Institute [10]. It uses the quality attributes from the ATAM but also consider cost when reasoning around the most suitable architecture. As well as ATAM this method is developed for software but it is believed to be easily adapted for use on the complete E/E architecture. The use of ATAM for a complete E/E architecture is suggested in [8], and a combination of ATAM and AHP to use as decision support when integrating new functionality in the automotive domain is outlined in [17]. It is important to point out that neither ATAM or CBAM takes any decisions, it works more as aiding in the decision process.
3 Central literature and seminal papers

One seminal paper is the description of the AHP method by T.J Saaty [16]. As central literature the descriptions on ATAM [11] and CBAM can be mentioned [10]. Larses is in his interesting thesis discussing the architecting and modeling of automotive embedded systems [12]. He suggests a quantitative approach for architecture design and evaluation of modular architectures.

4 Key conferences

4.1 INCOSE

The international council on systems engineering (INCOSE) [3] holds an annual symposium that is considered among the biggest although the academic quality is shifting due to the large number of papers submitted by industry. Many of them are more experience paper from industry and the academic value can sometimes be questioned. This year the annual symposium is held in San Diego [4].

4.2 ICSE

The International Conference on Systems Engineering (ICSE) is the most well merited conference within software engineering. This year the conference is held in Minneapolis [1] and also holds an automotive workshop.

4.3 ESEC/FSE

European Software Engineering Conference (ESEC) and Foundations of Software Engineering (FSE) are held in conjunction in Croatia this year. This is also considered to be one of the key conferences within software engineering.

4.4 SAE

The Society of Automotive Engineers is an organization arranging a few conferences. The biggest is their world congress [5] held in Detroit annually. A more academic SAE conference is the SAE convergence [6].
5 Research groups and institutes

5.1 Applied software engineering group

The applied software engineering group at Chalmers University of Technology is one of the research groups in the area. They aim at providing industry with more dependable software at lower development and maintenance cost.

5.2 Center for Systems and Software Engineering

The Center for Systems and Software Engineering at the University of Southern California has a software architecture group studying software architectures and their impact on the overall life-cycle of software systems.

5.3 Embedded control systems group

The embedded control systems group at the Royal Institute of technology focuses on architectural design within mechatronic products.

5.4 Carnegie Mellon Software Engineering Institute

The Carnegie Mellon Software Engineering Institute is a US government funded research institution with a software engineering process management program. They have developed both ATAM and CBAM and are also authors of the Captivity Maturity Model (CMM) and its successor the Captivity Maturity Model Integration (CMMI) that is a process improvement approach that provides organizations with the essential elements of effective processes.

References


