# COMPARISON OF GLOBAL IMPLEMENTATIONS OF AUTOSAR

by

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*To my loving wife, Pam, I am forever grateful for your love and support!*

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# DEFINITIONS

- ARXML: AUTOSAR XML file, an XML-based file containing software architecture and description information. An essential work product of the AUTOSAR methodology.
- AUTOSAR (AUTomotive Open System ARchitecture): A standard for automotive software architecture and development.
- AUTOSAR Core Partner: One of nine founding companies of the AUTOSAR organization.
- AUTOSAR Associate Partner: Companies that are currently using the AUTOSAR standard.
- AUTOSAR Attendee: Organizations such as universities and non-profit organizations collaborating with Core, Premium, and Development partners to define the AUTOSAR standard.
- AUTOSAR Development Partner: Smaller companies collaborating with Core and Premium Partners to define the AUTOSAR standard.
- AUTOSAR Premium Partner: Market leaders collaborating with Core and Development Partners to define the AUTOSAR standard.
- AUTOSAR Subscriber: Individuals from the public making use of the standard.
- Base Software (BSW):
- Component: A component is the smallest unit of software in AUTOSAR.
- Composition: A composition is a grouping of two or more related components or compositions.
- Controller Area Network (CAN): CAN is a network standard for electronic control units.
- Original Equipment Manufacturer (OEM): OEMs create the final assembled product, typically the new vehicle.
- Run-Time Environment (RTE): Also called Virtual Function Bus (VFB), the RTE is the abstraction layer between the application components (SW-C) and the Base Software (BSW).
- SAE J-1939: Society of Automotive Engineers standard application layer network protocol for heavy-duty vehicles.
- Skeleton model: Software or models constructs that establish AUTOSAR interfaces but have no logic implemented.
- Tier 1 Supplier: A company that sells directly to specific OEMs.

- Tier 2 Supplier: A company that sells commodity parts to OEMs and Tier 1 Suppliers.
- Virtual Function Bus: The mechanism through which AUTOSAR components exchange messages regardless of whether the component is on the same core, ECU, or external to the ECU.

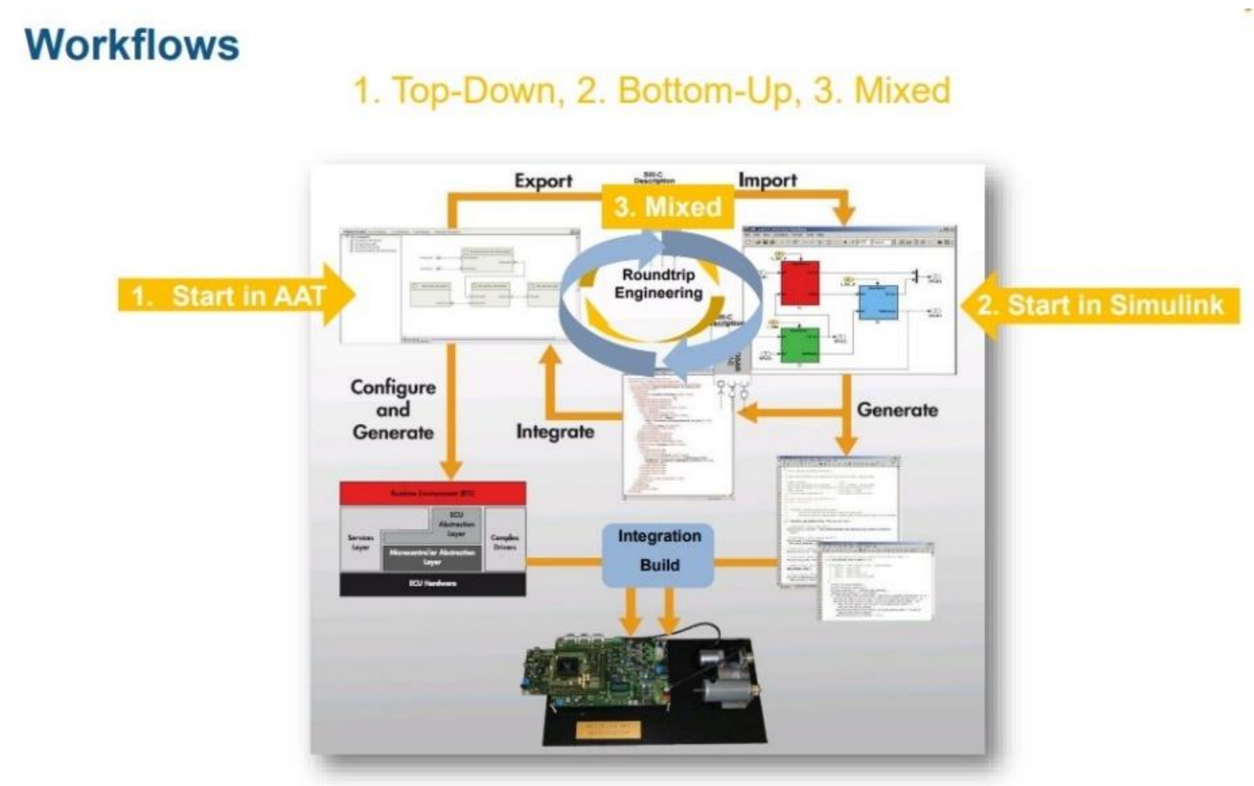
# ABSTRACT

Since the incorporation of electronic controls into automobiles in the 1970s, the complexity of automotive software has steadily increased. Recent cars and trucks have more electronics and lines of code than modern aircraft. This complexity has made the commoditization of the software exceptionally challenging. The AUTomotive Open System ARchitecture (AUTOSAR) standard was created to enable original equipment manufacturers (OEMs), Tier 1 and Tier 2 Suppliers, Vendors, and other players in automotive software to freely buy, sell, and integrate software components for automotive applications. AUTOSAR does this through a standardized set of software interfaces and a methodology for enabling software exchange, allowing software tools to interoperate. This study explored how AUTOSAR practitioners go about the business of conducting the methodology and its perceived benefits and problems. A global survey of AUTOSAR practitioners was conducted to collect company and respondent demographic information and details concerning specific practices. The survey results indicated practitioners believe AUTOSAR was good at abstracting hardware from the software and between the software components. Respondents also indicated that the AUTOSAR methodology was complicated and not sufficiently prescriptive, leading to inconsistent interpretation and application. Based on the survey results, it was concluded that more work is needed to provide more decisive clarity and direction for AUTOSAR practitioners.

# CHAPTER 1: INTRODUCTION

For over 30 years, the automotive industry has used software to control engines and other automotive systems (Broy, Kruger, Pretschner, & Salzmann, 2007; Staron, 2017). What started as small, resource-constrained hardware with application-specific software such as ignition control has evolved into modern vehicles with hundreds of control units and millions of lines of code (Broy, Kruger, Pretschner, & Salzmann, 2007; Staron, 2017). Applications for these software systems include engine and transmission controls, braking systems, air bag controls, advanced driver assistance systems, autonomous driving, and even infotainment systems (Bjelica & Lukac, 2019; Broy, Kruger, Pretschner, & Salzmann, 2007; Staron, 2017; Unseld, 2020). OEMs commonly purchase parts of these systems, complicating applications further. Initially, integration of the application was at the network level via proprietary and then standard protocols such as SAE J-1939 over Controller Area Network (CAN). In the last 15 to 20 years, this level of integration moved beyond networks and into the software itself. With this level of software integration, software architecture and standards take on new importance for the automotive industry from such varied sources. AUTOSAR was formed in 2003 to answer this challenge (AUTOSAR, n.d. a) and released AUTOSAR Classic in 2005, including a standard for methodology (AUTOSAR, n.d. a) and included.

The AUTOSAR Classic standard version 4.4.0 provides a standard methodology (AUTOSAR, 2018). The AUTOSAR methodology prescribes the steps necessary to develop a system for AUTOSAR, starting with creating the Virtual Function Bus to the final target executable (AUTOSAR, 2018, p. 18). The AUTOSAR methodology does not provide a complete process definition but individual aggregates to develop the final running system software (AUTOSAR, 2018, p. 18). Additionally, while the AUTOSAR methodology provides example patterns, the standard does not specify the sequence of the steps required to carry out AUTOSAR software development (AUTOSAR, 2018, p. 19). The AUTOSAR Classic Methodology briefly describes three generalized workflows: Top-Down, Bottom-Up, and Round-Trip Engineering. As illustrated in Figure 1, the Top-Down workflow defines the architecture first, after which the generation of the virtual function bus is completed prior to any component implementation. The Bottom-Up workflow sees the component designed and integrated before generating the virtual function bus. The Round-Trip Engineering workflow combines Top-Down and Bottom-Up by first conducting the Top-Down workflow. After implementation, the Bottom-Up pushes any architectural changes into the system (AUTOSAR, 2018).




Note: Reprinted from Model Based Development for AUTOSAR Software Components (2019, p. Understanding the Importance of Workflow in AUTOSAR Compliant Model Based Development)

**Figure 1**

*AUTOSAR Workflows*

## 1.1. Statement of the Problem

There is ambiguity in the AUTOSAR Methodology which leaves interpretations of the AUTOSAR standard to the individual entities developing an AUTOSAR system (Sung & Han, 2013). These interpretations vary widely internally and between the numerous players in the AUTOSAR ecosystem, including Vendors, OEMs, Tier 1 and Tier 2 suppliers. These interpretations result in inconsistent approaches to workflows and implementations of the AUTOSAR Methodology. Consequently, authoring and development tools for AUTOSAR must be flexible enough to support a myriad of methodologies and are correspondingly complex to use. Organizations and teams adopting AUTOSAR initially have no formally recognized templates for workflows and applications to use as a basis for organizing and planning.

Previous research has chiefly looked into the benefits and drawbacks of AUTOSAR (Martínez-Fernández, Ayala, Franch, & Nakagawa, 2015) or have focused strictly on the development of an executable ECU application (Hermans, Ramaekers, Denil, Meulenaere, & Anthonis, 2011; Franco, Neme, Santos, da Rosa, & Dal Fabbro, 2016). This research compared how different OEMs, Suppliers, and Vendors approach AUTOSAR architecture and workflows, confirmed the commonality of methods, identified the differences, and proposed recommendations for addressing the divergence amongst the practitioners of AUTOSAR.

## 1.2. Research Questions

The asking of these three Research Questions (RQ) aided in fulfilling the purpose of this study.

- RQ1: What factors facilitate the application of the AUTOSAR Methodology?
- RQ2: What factors impede the application of the AUTOSAR Methodology?
- RQ3: What are the best practices for developing an AUTOSAR application? Such as how many architects and at what level are they employed (system, subsystem, component).

## 1.3. Significance of the Study

Lack of a unified workflow definition within the AUTOSAR standard causes difficulty and inefficiencies in implementing the system. Something as simple as who defines an interface and when can result in disagreement, conflict, and weeks of delays to the schedule. Other needs not addressed include management of shared utility functions, i.e., how are multiple components integrated when referencing the same functions. Preliminary research has revealed that other researchers have identified this lack of workflow specificity in the standard as an issue (Hermans, Ramaekers, Denil, Meulenaere, & Anthonis, 2011). This lack of specificity in the standard can require ad-hoc customizations to tools and workflows to accommodate development needs (Franco, Neme, Santos, da Rosa, & Dal Fabbro, 2016). Other research also indicated that knowledge of the methodology is not widely studied academically (Franco, Neme, Santos, da Rosa, & Dal Fabbro, 2016).

## 1.4. Purpose of the Study

The purpose of this qualitative study was to survey how AUTOSAR practitioners implemented AUTOSAR and included OEMs, Tier 1 or Tier 2 suppliers, and software and tool vendors. This analysis was conducted to determine commonalities in the workflows implemented, and more importantly, disagreement in approaches to AUTOSAR and why. Further, this study proposed future research, mades recommendations for changes to the AUTOSAR Methodology and presented best practices. The proposed propose of this study was to understand aspects of practicing the AUTOSAR Methodology by answering the research questions through a survey of the worldwide population of AUTOSAR practitioners. The duration of the study was two weeks and covered topics such as organizational responsibilities, application software sizing, and captured demographics of the respondents such as background, role, company location, and company role in AUTOSAR. The study aimed to engage with practitioners globally and assumed primarily located in Europe, Japan, and the United States.

## 1.5. Limitations

Limitations of the study included:

- The study was an internet-based survey of AUTOSAR users from LinkedIn groups and that those that joined the groups may not be representative of all AUTOSAR practitioners.
- The LinkedIn group members who respond to the survey might not represent the entire population of AUTOSAR practitioners.
- The study utilized an internet-based survey due to COVID and a lack of travel budget and conducted data analysis with already available tools (i.e., Minitab, Matlab, and so on).

## 1.6 Delimitations

Delimitations of the study were:

- This qualitative study was a global survey of OEMs, Tier 1 and 2 suppliers, and software and tool vendors presently or formerly employing the AUTOSAR methodology.
- Maintaining the anonymity of the respondents was accomplished by constructing the survey questions without asking for personally-identifying information.
- This study did not solicit participants for any documentation of processes, workflows, or other private or proprietary work products.
- The AUTOSAR organization assisted with recruiting participants for the proposed study (AUTOSAR, n.d. b).
- This research explored AUTOSAR processes and workflows, focusing on the verification and validation V-Model of software development utilized by the automotive industry instead of the waterfall or agile process models (Balaji & Murugaiyan, 2012).

## 1.7. Assumptions

Assumptions for the study included:

- Those surveyed would be willing to participate in the survey.
- Software vendors, tool vendors, and tier 2 suppliers will be most forthcoming.
- OEMs, Tier 1 suppliers, and those hesitant to share details about their methodologies or trade secrets will be least forthcoming.
- Tools used were already available to complete all work.
- This study would involve a survey of human subjects meaning that Institution Review Board (IRB) review, and approval was required prior to contacting any participants.

## 1.8. Summary

This research was interested in understanding how practitioners in the automotive industry approach AUTOSAR to understand where and why there is divergence in approaches. Understanding these different approaches helped to understand that the AUTOSAR methodology standard should be revised, identified areas for new research, and suggestions for the AUTOSAR organization.

# CHAPTER 2: REVIEW OF THE RELEVANT LITERATURE

The stated purpose of this research was to understand how the automotive industry develops AUTOSAR. A review of relevant literature clarified the "V" diagram and its applicability to AUTOSAR development practices. Second, examining the literature provided an understanding of how other industries, such as aerospace, approach standardized software architecture and methodologies. Lastly, the literature review will help identify gaps in the current knowledge base and industry practices.

## 2.1. Literature Review Methodology

A literature review is more than running a handful of queries against some number of databases. To be effective and to have an assurance of having performed as thorough a search as possible, Dyrenfurth specifies an eight-step process for conducting a literature review: Establish the problem/goal, select the key terms, generate a concept map, select databases, check thesauri, develop search logic, conduct searches, record results (2019, p. 16). Modeling Dyrenfurth's framework while reviewing the literature resulted in a deeper understanding of AUTOSAR.

### 2.1.1. The problem/goal

There is ambiguity in the AUTOSAR methodology, leading to AUTOSAR practitioners encountering problems while implementing software compliant to AUTOSAR. The literature review identified what was known and revealed gaps in the understanding of AUTOSAR.

### 2.1.2. Key Terms

The key terms to find relevant literature included AUTOSAR, standard, application sizing, methodology, software architecture, process model, problems, workflow.

### 2.1.3. Concept Map

A concept map is helpful to document concepts and their relationships (Dyrenfurth, 2019, p. 19). As highlighted by the concept map for AUTOSAR, as presented in Figure 2, practitioners can encounter many issues while practicing AUTOSAR.  This concept map aided in the selection of search terms.

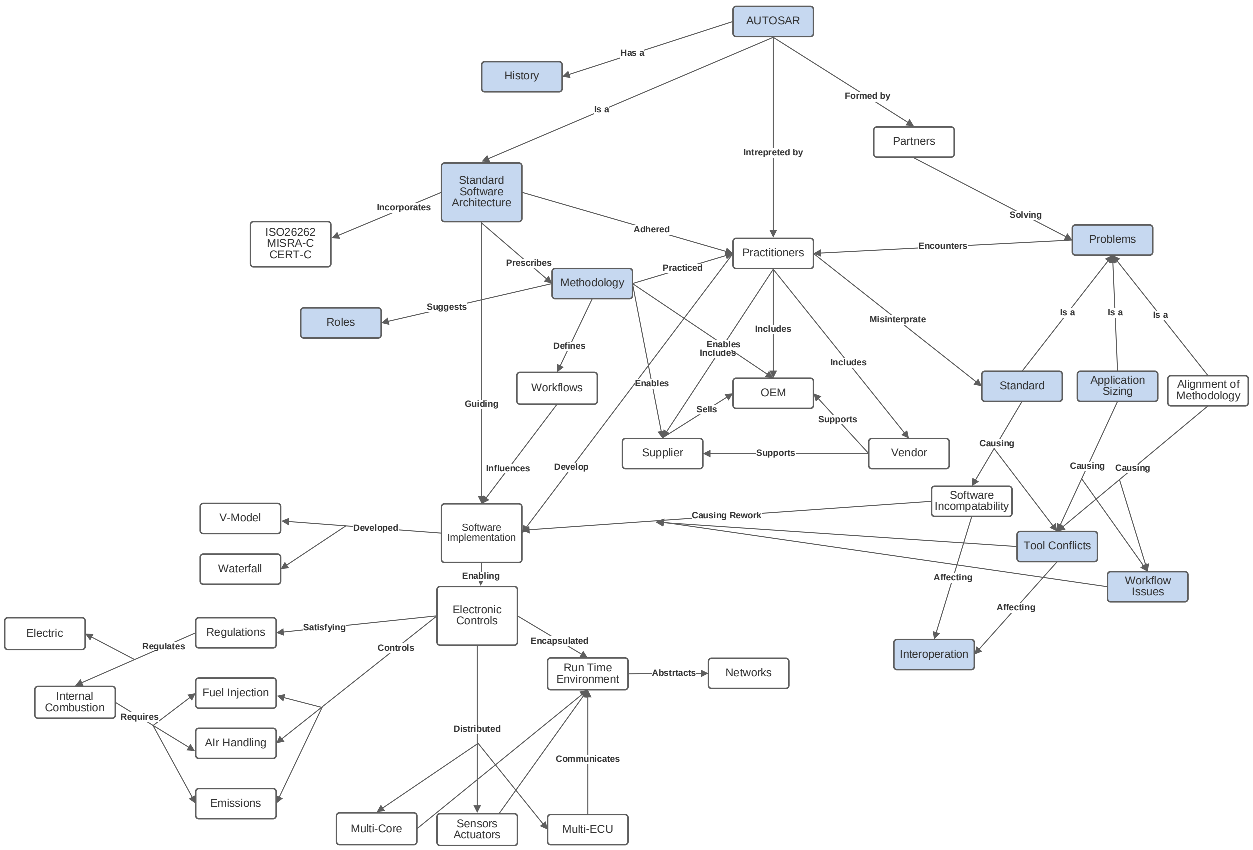



**Figure 2**

*AUTOSAR Concept Map*

### 2.1.4. Databases

The selection of the Purdue University Library and Google Scholar search engines can search many databases that are both known and unknown to the individuals conducting searches. Additionally, the non-academic Google search engine can find information not found in the published research, such as background, history, and other generalized information related to AUTOSAR and automotive software in general.  Searches were first performed in the Purdue and Google search engines without limiting them to specific databases.  After initial searches failed to return authoritative sources, additional searches were conducted via Google Scholar, explicitly filtering for theses and dissertations, returning finds in databases such as DiVA - Academic Archive Online.

### 2.1.5. Check Thesauri

Utilizing a thesaurus to expand the list of search terms is useful when the primary search teams do not find relevant information. Listed in Table 1 are the search terms and their alternatives.

**Table 1**

*Alternative Search Terms*

| Term | Alternatives |
|---|---|
| AUTOSAR | Reference software architecture |
| Standard | Specification, Guideline, Benchmark |
| Application sizing | |
| Methodology | Practice, Procedure, Method, Approach |
| Software architecture | Software style, Software design |
| Process model | Pattern, paradigm, standard, framework, workflow |
| Problems | Difficulties, issues, challenges, concerns |
| Workflow | Process model |

### 2.1.6. Search Logic

Referring to Figure 3, a Venn Diagram was constructed based on the concept map and search terms. A number of the terms were generally related to AUTOSAR and were used to find foundational information about AUTOSAR and include partners, history, and reference architectures. Methodology, problems, and the combination of methodology and problems was cosidered be too broad without additional search terms to further refine the search.

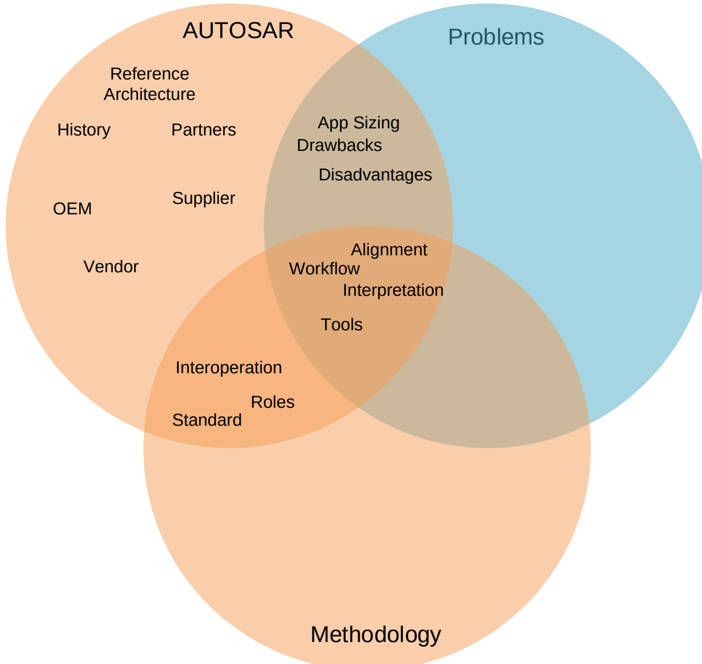



**Figure** 3

*Literature Search Venn Diagram*

Based on the Venn diagram, the search logic is constructed and presented in Table 2.

**Table 2**

*Literature Search Logic*

| Category | Description | Search Logic |
|---|---|---|
| AUTOSAR | The central topic is the AUTOSAR standard. | AUTOSAR AND reference architecture<br>AUTOSAR AND history<br>AUTOSAR AND partners |
| AUTOSAR + Problems | The problems associated with AUTOSAR | AUTOSAR AND problems<br>AUTOSAR AND application sizing<br>AUTOSAR AND drawbacks<br>AUTOSAR AND disadvantages |
| AUTOSAR + Methodology | Topics related to AUTOSAR Methodology | AUTOSAR AND methodology AND roles<br>AUTOSAR AND methodology AND standard<br>AUTOSAR AND methodology AND interoperation |

**Table 2** (continued)

| | | |
|---|---|---|
| AUTOSAR + Methodology + Problems | The problems associated with the AUTOSAR methodology | AUTOSAR AND methodology AND problems AND workflow<br>AUTOSAR AND methodology AND problems AND alignment<br>AUTOSAR AND methodology AND problems AND interpretation<br>AUTOSAR AND methodology AND problems AND tools |

### 2.1.7. Searches and Results

With the search strings listed in table 2, the Purdue University Library and Google Scholar search engines were queried and summarized in table 3, including the result count and the first three items returned for the search term. A summary of the search results is provided in Table 3, while Table 4 shows any item found in more than one search, of which there are 10. With five search hits, A Survey on the Benefits and Drawbacks of AUTOSAR was the top article found. While not an indication of the article's research value, it was examined closely.

**Table 3**

*Search Results*

| Search Term | Purdue University Library Results | Google Scholar Results |
|---|---|---|
| AUTOSAR AND reference architecture | • 1,356 Results<br>• Metric-based Evaluation of Powertrain Software Architecture.<br>• Autosar OPEN STANDARD TO TACKLE AUTOMOTIVE ELECTRONIC COMPLEXITIES.<br>• AUTOSAR Model-Based Software Component Integration of Supplier Software. | • 'About' 7,290 results<br>• A Survey on the Benefits and Drawbacks of AUTOSAR<br>• AUTOSAR Standard<br>• AUTOSAR – The standardized software architecture |

**Table 3** (continued)

| | | |
|---|---|---|
| AUTOSAR AND history | • 650 Results<br>• RTI Named AUTOSAR Development Partner<br>• Parasitic Battery Drain Problems and AUTOSAR Acceptance Testing.<br>• Assessing the impact of meta-model evolution: a measure and its automotive application. | • 'About' 1,470 results<br>• The AUTOSAR Timing Model–Status and Challenges<br>• Autosar—shaping the future of a global standard<br>• Development of AUTOSAR standard documents at Carmeq GmbH: a case study |
| AUTOSAR AND partners | • 1400 Results<br>• AUTOSAR Software Industry Report 2020: Overview, Adaptive AUTOSAR and Development Roadmap, Adaptive AUTOSAR Cases & Software Developers<br>• C2A Security Joins Leading OEMs and Tier 1s in Partnership With Global Automotive Platform Consortium AUTOSAR<br>• AUTOSAR gears up for autonomous driving. | • 'About' 1550 results<br>• AUTOSAR–A Worldwide Standard is on the Road<br>• Achievements and exploitation of the AUTOSAR development partnership<br>• AUTOSAR for connected and autonomous vehicles: The AUTOSAR adaptive platform |
| AUTOSAR AND problems | • 1394 results<br>• Parasitic Battery Drain Problems and AUTOSAR Acceptance Testing<br>• Design optimization for AUTOSAR models with preemption thresholds and mixed-criticality scheduling<br>• Applying AUTOSAR Network Management in OSEK/VDX for Compatibility of AUTOSAR and OSEK/VDX | • 'About' 4,640 results<br>• Analysis and validation of AUTOSAR models<br>• AUTOSAR-ready light software architecture for automotive embedded control systems<br>• A Survey on the Benefits and Drawbacks of AUTOSAR |

**Table 3** (Continued)

| | | |
|---|---|---|
| AUTOSAR AND application sizing | • 923 results<br>• AUTOSAR Runnable Periods Optimization for DAG-Based Complex Automobile Applications<br>• DEVS for AUTOSAR-based system deployment modeling and simulation<br>• Verifying the Accuracy of Automation Tools for the Measurement of Software with COSMIC -- ISO 19761 Including an AUTOSAR-Based Example and a Case Study | • 'About' 200 results<br>• Functional size measurement for processor load estimation in AUTOSAR<br>• COSMIC Solver: A Tool for Functional Sizing of Java Business Applications<br>• Mechanisms for guaranteeing data consistency and flow preservation in AUTOSAR software on multi-core platforms |
| AUTOSAR AND drawbacks | • 221 Results<br>• Parasitic Battery Drain Problems and AUTOSAR Acceptance Testing.<br>• Metric-based Evaluation of Powertrain Software Architecture<br>• Protection of Intellectual Property Rights in Automotive Control Units. | • 'About' 1400 results<br>• A Survey on the Benefits and Drawbacks of AUTOSAR<br>• Model-based extension of autosar for architectural online reconfiguration<br>• Automated generation of AUTOSAR description file for safety-critical software architectures |
| AUTOSAR AND disadvantages | • 229 results<br>• Assessing the impact of meta-model evolution: a measure and its automotive application.<br>• Timing Analysis for Hypervisor-based I/O Virtualization in Safety-Related Automotive Systems.<br>• Automated Generation and Integration of AUTOSAR ECU Configurations | • 'About' 1280 results<br>• On reducing busy waiting in AUTOSAR via task-release-delta-based runnable reordering<br>• Optimized scheduling of multicore ECU architecture with bio-security CAN network using AUTOSAR<br>• Implementing a CAN-most gateway with Autosar basic software |

**Table 3** (Continued)

| | | |
|---|---|---|
| AUTOSAR AND methodology AND roles | • 515 results<br>• AUTOSAR Model-Based Software Component Integration of Supplier Software.<br>• Fitting the CHESS Approach to the AUTOSAR Development Flow.<br>• Autosar OPEN STANDARD TO TACKLE AUTOMOTIVE ELECTRONIC COMPLEXITIES. | • 'About' 2230 results<br>• AUTOSAR Standard<br>• Enhancing AUTOSAR methodology to a cots based development process via mapping to V-Model<br>• A Survey on the Benefits and Drawbacks of AUTOSAR |
| AUTOSAR AND methodology AND standard | • 1117 results<br>• AUTOSAR - A Worldwide Standard is on the Road.<br>• Ten Years of AUTOSAR -- Establishing a Worldwide Standard for E/E Systems.<br>• Autosar OPEN STANDARD TO TACKLE AUTOMOTIVE ELECTRONIC COMPLEXITIES. | • 'About' 3980 results<br>• AUTOSAR–A Worldwide Standard is on the Road<br>• AUTOSAR for connected and autonomous vehicles: The AUTOSAR adaptive platform<br>• AUTOSAR–Current results and preparations for exploitation |
| AUTOSAR AND methodology AND interoperation | • 5 results<br>• A formal model of services<br>• Exploring Use of Ethernet for In-Vehicle Control Applications: AFDX, TTEthernet, EtherCAT, and AVB<br>• A systems of systems perspective on the internet of things: invited paper | • 'About' 2450 results<br>• Timing modeling and analysis for AUTOSAR-based software development- a case study<br>• Apparatus and method for verifying interoperability between application software and autosar service<br>• A Survey on the Benefits and Drawbacks of AUTOSAR |

**Table 3** (Continued)

| | | |
|---|---|---|
| AUTOSAR AND methodology AND problems AND workflow | • 89 results<br>• SAMM: an architecture modeling methodology for ship command and control systems.<br>• Metric-based Evaluation of Powertrain Software Architecture.<br>• Automated Generation and Integration of AUTOSAR ECU Configurations | • 'about' 903 results<br>• Timing simulation of interconnected AUTOSAR software-components<br>• An integrated approach for modeling, analysis and optimization of systems whose design follows the east-adl2/autosar methodology<br>• An ILP approach for mapping autosar runnables on multi-core architectures |
| AUTOSAR AND methodology AND problems AND alignment | • 64 results<br>• Using UML/MARTE to support performance tuning and stress testing in real-time systems.<br>• Prototypes to prove concepts.<br>• AUTILE Framework: An AUTOSAR Driven Agile Development Methodology to Reduce Automotive Software Defects | • 'about' 1160 results<br>• Design and implementation procedure of the AUTOSAR I/O driver cluster<br>• Definition and generation of data exchange formats in AUTOSAR<br>• Development of localisation and mapping software for autonomous cars |
| AUTOSAR AND methodology AND problems AND interpretation | • 136 results<br>• Assessing the impact of meta-model evolution: a measure and its automotive application.<br>• Metric-based Evaluation of Powertrain Software Architecture.<br>• A Model-Driven Co-Design Framework for Fusing Control and Scheduling Viewpoints. | • 'About' 2,070 results<br>• Model interpretation for an AUTOSAR compliant engine control function<br>• Strobilus-Test Application Generator for AUTOSAR systems<br>• Formal methods based acceptance testing for AUTOSAR exchangeability |

**Table 3** (Continued)

| | | |
|---|---|---|
| AUTOSAR AND methodology AND problems AND tools | • 672 results<br>• Parasitic Battery Drain Problems and AUTOSAR Acceptance Testing.<br>• A taxonomy of tool-related issues affecting the adoption of model-driven engineering.<br>• Assessing the impact of meta-model evolution: a measure and its automotive application. | • 'About' 3120 results<br>• AUTOSAR and the automotive tool chain<br>• From EAST-ADL to AUTOSAR software architecture: a mapping scheme<br>• Timing simulation of interconnected AUTOSAR software-components |

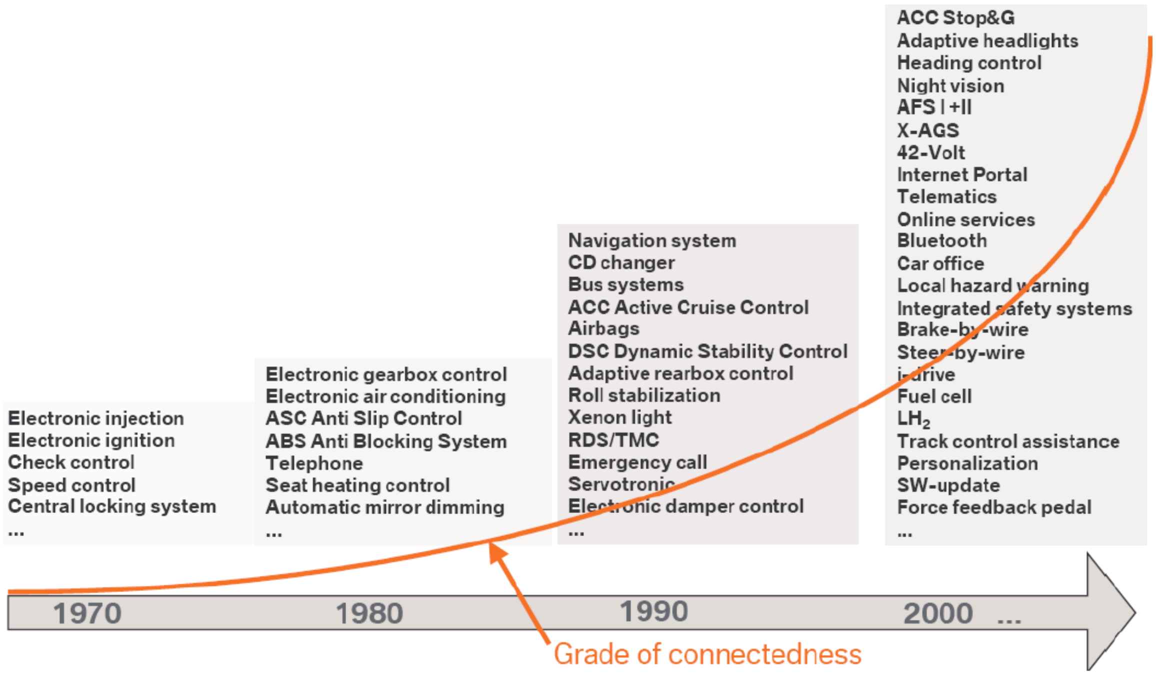
**Table 4**

*Top 10 Search Results*

| Hit Count | Source |
|---|---|
| 5 | A Survey on the Benefits and Drawbacks of AUTOSAR |
| 4 | Metric-based Evaluation of Powertrain Software Architecture |
| 4 | Parasitic Battery Drain Problems and AUTOSAR Acceptance Testing |
| 4 | Assessing the impact of meta-model evolution: a measure and its automotive application |
| 3 | AUTOSAR [sic] Open Standard to Tackle Automotive Electronic Complexities |
| 2 | AUTOSAR Standard |
| 2 | AUTOSAR Model-Based Software Component Integration of Supplier Software |
| 2 | AUTOSAR for connected and autonomous vehicles: The AUTOSAR adaptive platform |
| 2 | Automated Generation and Integration of AUTOSAR ECU Configurations |
| 2 | Timing simulation of interconnected AUTOSAR software-components |

## 2.2. A Brief History of Automotive Software

AUTOSAR is a reference software architecture at its core. It is generalized, providing abstract classes from which all using the reference can define a specific system (Staron, 2017; Martínez-Fernández, Ayala, Franch, & Nakagawa, 2015). Before AUTOSAR can be fully defined or explained, it is essential to understand how software entered into the automotive domain at a high level. At their onset, automobiles were mechanically controlled hydrogen or gasoline-powered forms of transportation (The History of Embedded Systems in Cars, 2016). The federal government began regulating emissions and fuel economy in the 1970s (Laurens, 2019; The History of Embedded Systems in Cars, 2016); and ever since, the automotive industry has used software to control engines and other automotive systems (Broy, Kruger, Pretschner, & Salzmann, 2007; Staron, 2017). The first use case for electronic control of automobiles was controlling ignition and fuel injection. In the 1980s, auto racing began installing telemetry computers to enable live data monitoring and recording during a race (BMW, 2020). In the 1990s, engine control software made onboard diagnostics (OBD) a reality, allowing more than just dealerships to work on cars again (Laurens, 2019). Today, computers and the software that runs in them are ubiquitous in automobiles, and it is this ubiquity that has caused the electronic control systems of automobiles to become unmanageably complex (Laurens, 2019; Bjelica & Lukac, 2019; Broy, Kruger, Pretschner, & Salzmann, 2007; Staron, 2017; Unseld, 2020). Charette (2021) explained that the complexity of automotive embedded systems and software has grown to tens of millions of lines of code and more control units than an Airbus A380. Kahn (2020) stated that the 2009 Mercedes-Benz S Class contains 20 million lines of code while the 2017 Fort F-150 pickup is 150 million lines of code. OEMs have begun to outsource many electronic and software components to suppliers and software tools to vendors, adding to the complication of automotive software even more and leading to increased safety and security problems (Ferguson, 2018; Dakermandji, 2008; Miller & Valasek, 2015).




Note: Reprinted from Dakermandji (2008, p. 17).

**Figure 4**

*Timeline of Automotive Complexity*

### 2.3. What is AUTOSAR

Now that it is established how software and electronic control entered into use within the automotive industry, an exploration of what AUTOSAR is follows. According to Dakermandji, AUTOSAR began as a "German discussion club in August [sic] 2002" (2008, p. 17). AUTOSAR began in earnest as a collaboration of OEMs, suppliers, and tools vendors in 2003 (AUTOSAR, n.d. a; Martínez-Fernández, Ayala, Franch, & Nakagawa, 2015; Nazareth & Siwy, 2013; Stroop, Eisemann, & Geburzi, 2013; Dakermandji, 2008). The motivations and goals for AUTOSAR include ease of integration, focus on function, lower costs, increased quality, reuse, scalability, portability, and maintainability (Layal, 2016; Dakermandji, 2008; Moghaddam, 2013; De Bernardo, 2019). Today, AUTOSAR is comprised of over 280 partners of varying participation levels, including Core, Premium, Development, Strategic, Associate, Attendee

Partners, and Vendors (AUTOSAR, 2020h). Appendices A-G provide an exhaustive listing of each.


Note: Adapted from (AUTOSAR, 2020h, p. 12)

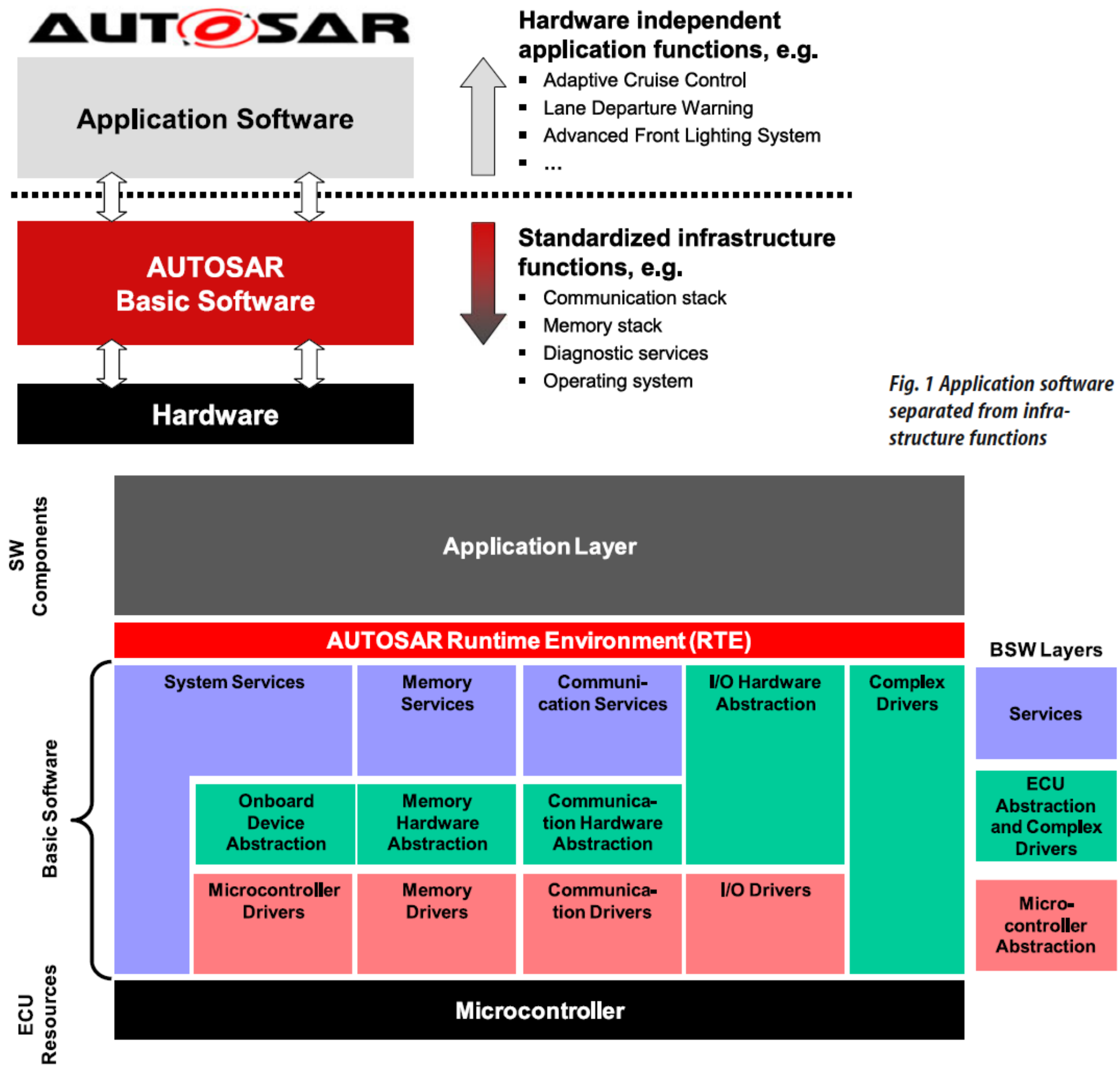
**Figure 5**

*AUTOSAR Partners*

Janardhan (2018), Martínez-Fernández et al. (2015), and Staron (2017) described AUTOSAR as a reference architecture for automotive software. Kumar, Yoo, and Hong (2009) and Bunzel (2011) refered to AUOSAR as a standard architecture. Bunzel (2011) further described AUTOSAR as a layered architecture. Kumar, Yoo, and Hong (Kumar, Yoo, & Hong, 2009) described AUTOSAR as a platform standard. Diekhoff called AUTOSAR “a de facto standard for software architecture in vehicle control systems” (2010, p. 263). The AUTOSAR specification goes beyond defining a standard architecture by providing a methodology by which specific implementations of AUTOSAR compliant components and applications are created (AUTOSAR, 2018).

In practice, the AUTOSAR standard divides an embedded software system into three general layers: Application, runtime environment, and base Software (Nazareth & Siwy, 2013;

Bunzel, 2011; Hermans, Ramaekers, Denil, Meulenaere, & Anthonis, 2011). The application layer consists of hardware-agnostic software components (SW-C) integrated with a physical system. The base software is a collection of complex device drivers, communications stacks, memory management, hardware abstraction, and other operating system features. The runtime environment between the application and base software layers, also known as the virtual function bus, is a data exchange mechanism that allows the application software components to be agnostic of the physical system. This generalized architecture and data exchange is what the AUTOSAR standard covers and is what allows OEMs, suppliers, and vendors in the automotive industry to collaborate, interoperate, and compete (Janardhan, 2018; Nazareth & Siwy, 2013; Bunzel, 2011; Hermans, Ramaekers, Denil, Meulenaere, & Anthonis, 2011).




Note: Reprinted from Bunzel (2011, p. 80).

**Figure 6**

*AUTOSAR Reference Architecture*

## 2.4. Benefits and Drawbacks of AUTOSAR

Martínez-Fernández et al. (2015) conducted a study in which AUTOSAR practitioners were asked about their perceived value of and issues with AUTOSAR, asking the respondents two mandatory questions and 11 optional questions to understand the demographics of the respondents. The two mandatory questions asked were "Which are the benefits of using AUTOSASR?" and "Which are the drawbacks and risks of using AUTOSAR?" (Martínez-Fernández et al., 2015, p. 20). Both questions provided a list of predefined responses and a free entry option. Each response also provided a free form entry allowing respondents to elaborate on their answers. Respondents were also allowed to select as many of the options as desired. The demographic questions asked respondents to specify their names, email addresses, fields of study, company name, whether their company is an OEM, tier 1 supplier, tier 2 supplier, a vendor, or other. Martínez-Fernández et al advertised their survey at "professional meetings," the 6$^{th}$ AUTOSAR Open Conference, and two AUTOSAR specific LinkedIn groups with a combined size of 6,000 members (Martínez-Fernández et al., 2015, pp. 20-21). While the survey remains open for long-term study, at the time of publication, Martínez-Fernández et al. reported that 51 valid responses were received. Martínez-Fernández et al. noted that though this low response rate does not allow for generalization with other software architectures, it is similar to response rates obtained by other studies.

Martínez-Fernández et al. reported the benefits, with more than 50 percent responding with comments like standardization, reuse, and interoperability, while the benefits of AUTOSAR, receiving less than 25 percent of the responses, including risk reduction, mission/vision/strategy, reputation, novel design solutions, facilitation other, and none (2015, p. 23). Drawbacks receiving more than 50 percent responses included complexity, initial investment, and learning curve. Specifically, term confusion received 41 percent, bad documentation 20 percent, and bad quality received 10 percent (Martínez-Fernández et al., 2015, p. 24). Based on the responses gathered, Martínez-Fernández et al. concluded that software architectures are not always in agreement in an academic context and that additional research is needed to facilitate the industry's choice and usage of good techniques and methods for supporting the software architecture process (2015, p. 25).

## 2.5. AUTOSAR Methodology

The AUTOSAR methodology defines a generalized workflow (AUTOSAR, 2018; Kumar, Yoo, & Hong, 2009) utilizing the OMG Software Process Engineering Metamodel (Schreiner, 2009). Sreeram similarly described the AUTOSAR methodology as a "general technical approach to develop a system" (2019, p. 9). The AUTOSAR workflow can also be thought of in terms of work-product flow, defining the activities dependent on the work product flow (Layal, 2016; Schreiner, 2009; Sreeram, 2019). Beginning with the optional creation of an abstract design of the system, followed by the generation of a virtual function bus (VFB) which will be the formal start of development activities if skipping the abstract design step. Next, the software components (SW-C) are developed based on the specification of the VFB. The creation of the SW-Cs is irrespective of whether used on single-core, multiple cores, or multiple ECUs. The AUTOSAR methodology also specifies a two-phase approach with the OEM organization specifying the overall system design while defining subsystems is left to the other supplier organizations (AUTOSAR, 2018; Sreeram, 2019). The various organizations communicate via system extracts, i.e., ARXML files, containing ECU and other system information. Based on these extracts, the ECU's SW-C and Base Software (BSW) are developed, ultimately integrated, and compiled into a complete AUTOSAR application.

Sreeram (2019) pointed out that as of version 4.4.0, the AUTOSAR methodology also provides a list of roles and responsibilities, which the methodology defines as:

- AUTOSAR Partnership: "The AUTOSAR Partnership development defines standard artifacts."
- Basic Software Designer: "Role responsible for the overall design of the Basic Software."
- Basic Software Module Developer: "Role responsible to develop and deliver a Basic Software Module."
- Calibration Engineer: "The calibration engineer determines the calibration parameters of an ECU."
- Certification Agency: "The certification agency verifies the conformance of artifacts with respect to the standard artifacts defined by the AUTOSAR consortium."
- ECU Integrator: "Integrates the complete software on an ECU."

- Software Component Designer:  "Designer of software components and VFB systems."
- Software Component Developer:  "Developer of the software component code."
- System Engineer:  Responsible for the "Creation, management, development, and integration of systems within the vehicle."
- Non-AUTOSAR System Integrator:  "Responsibility for the quality of the description of the non-AUTOSAR system and its integration into the AUTOSAR process."
- Rapid Prototyping Engineer:  The AUTOSAR methodology standard did not describe this role.
- Safety Engineer:  "Responsibility for the safety relevant steps in the AUTOSAR development process" (AUTOSAR, 2018, pp. 209-220).

### 2.5.1. AUTOSAR Methodology in Practice

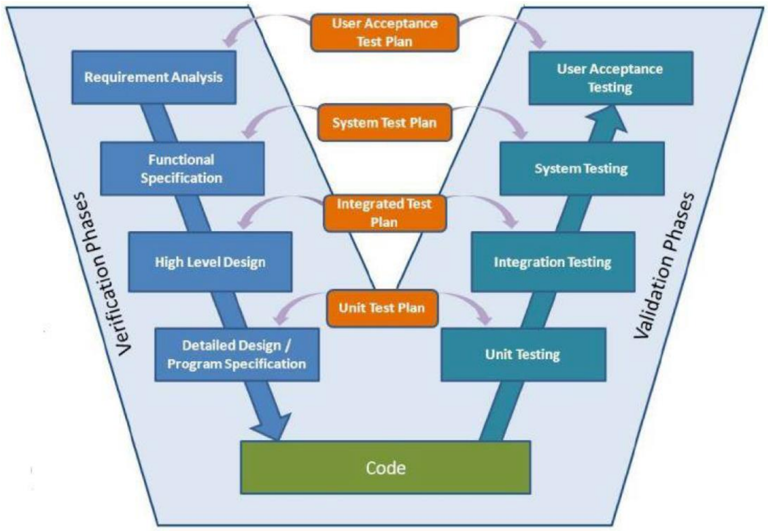
Bernardeschi, Di Natale, Dini, and Palmieri (2018), Bunzel (2011), Kumar, Yoo, and Hong (2009), Rajkumar, and Paralikar (2019), Staron (2017), Sung and Han (2013), and others mentioned that AUTOSAR specifies a methodology. Bernardeschi et al. described the AUTOSAR methodology as a development process (2018).  Janardhan (2018) explained AUTOSAR methodology as a sequence of various steps for implementation, while Bunzel told us that AUTOSAR methodology is a description of chief development phases (2011).  Nazareth and Siwy (2013) stated that the AUTOSAR methodology is a function rather than hardware-oriented. The AUTOSAR methodology uses a meta-model that expresses all the elements defining the AUTOSAR system in an ARXML file (Bunzel, 2011; Eisemann, Stichling, & Stroop, 2009; Sung & Han, 2013).  Franko, Neme, Santos, da Rosa, and Dal Fabbro (2016) and Nazareth and Siwy (2013) explained that the AUTOSAR methodology is a model-based development with the system model central to the development process.  Rajkumar and Paralikar also explained that the AUTOSAR methodology entails isolating the system into modular components (2019).  Stroop, Eisemann & Geburzi suggested that a particular benefit of the AUTOSAR methodology is the ability to virtually test the software much earlier (Stroop, Eisemann, & Geburzi, 2013).

The AUTOSAR methodology could then be merely a specification for ensuring the exchange of information between the layers of AUTOSAR development.  AUTOSAR methodology does not define any processes by which to accomplish the task of development. Sung and Han (2013) informed that the AUTOSAR methodology prescribes work products and their contents but no roles nor responsibilities and summarizes the methodology as a 4 step procedure. However, it should be noted that roles and responsibilities were not defined until the 4.4.0 version of the methodology was released in 2018 (AUTOSAR, 2018). Sung & Han's 4 step procedure begins at step one with defining the thing to be developed, including its requirements and constraints, describing the application component(s) separately from hardware, the hardware from application components, and then the physical system to include network and communication information. Step 2 involves the distribution of the application component description(s) to the target ECU; step 3 is the generation of the AUTOSAR configuration. Finally, step 4 is the compilation of the executable software.

Sung and Han explained that the AUTOSAR methodology is not a comprehensive process but rather a "… common technical approach for some steps…" (2013, p. 30). Consequently, Kumar et al. (2009) and Broy et al. (2007) insisted that the AUTOSAR methodology is insufficient to effectively address its stated goals or exploit uses beyond integrating software components. Kumar et al. listed three specific shortcomings of AUTOSAR Methodology: Failure to address critical functional parts of the process, lack of organizational perspective due to the lack of definition of roles and responsibilities, and the lack of a specified timeline, i.e., who does what and when (2009, p. 51). Kumar et al. recognized that this lack of process specificity is intentional but explain that many developers are "disappointed" by the lack of a fuller process definition (2009, p. 51). It should again be noted that AUTOSAR methodology provided definitions of roles and responsibilities in the 4.4.0 version of the standard (AUTOSAR, 2018; Sreeram, 2019). Broy et al. insisted that interface specification methods are generally not good enough, particularly for the automotive industry resulting in difficulties for "precise modeling of architecture" (2007, p. 369).

### 2.6. The V Model and AUTOSAR

The "V" or Validation & Verification model (V-Model) is a software development life cycle (SDLC) model which evolved from the traditional waterfall model (Balaji & Murugaiyan, 2012; De Bernardo, 2019; Khan, 2020). The Waterfall model is a sequential process with no overlapping steps or tasks and in which testing and documentation are performed only at the end (Balaji & Murugaiyan, 2012; De Bernardo, 2019; Khan, 2020). The primary downside to the waterfall model is that defects are found much later in the development cycle (Balaji & Murugaiyan, 2012). Referring to Figure 7, the V-model emphasizes verification and validation. The left side of the "V" incorporates requirements management, system, and function design and specification, while the right side of the "V" performs unit, integration, system, and user acceptance test (De Bernardo, 2019). The V-model's primary drawback is that it is not well suited to short-term projects (Balaji & Murugaiyan, 2012). The automotive industry uses the V-model heavily (Hermans, Ramaekers, Denil, Meulenaere, & Anthonis, 2011; Kumar, Yoo, & Hong, 2009; Nazareth & Siwy, 2013; Staron, 2017). The V-Model has become so pervasive in the automotive industry that the Automotive Software Performance Improvement and Capability determination (ASPICE) arose to support it (Automotive SIG, 2017; Komiyama, et al., 2019). The automotive functional safety standard ISO26262 also is based on the V-Model (Crots, Skentzos, & Bartz, 2014). Diekhoff (2010) pointed out that as of release 4.0 of AUTOSAR, many updates permit safety-critical and non-safety critical software components to coexist on the same ECU. However, for all the pervasiveness of the V-Model in automotive software development, Staron (2017) posited that AUTSOAR methodology follows waterfall rather than V-Model. The AUTOSAR methodology specification itself is all but silent on the subject, only stating that the methodology allows for different life cycle models (AUTOSAR, 2018).




Note: Reprinted from De Bernardo (2019, p. 33).

**Figure 7**

*A Typical V-Model*

## 2.7. Other Architecture Standards

There are numerous reference architectures like AUTOSAR both within and outside the automotive industry. Martínez-Fernández et al. (2015) highlighted JasPar (Japan Automotive Software Platform and Architecture) collaborating with Japanese companies to promote and reduce development costs. Fenn, Cornilleau, Oakshott, and Britto (2014) described the European Component Oriented Architecture (ECO, a standard created for European military avionics software. Like AUTOSAR, ECOA specifies how components interface with the rest of the software system but do not appear to prescribe specific processes. Fenn et al. (2014) and Crots, Skentzos, and Bartz (2014) called out the aviation software safety standard DO-178, and Crots, Skentzos, and Bartz illustrate how DO-178 and ISO-26262 align with each other along the V-Model. Martínez-Fernández et al. (2015) stated that AUTOSAR expresses a desire to expand beyond automotive software. AUTOSAR (n.d. c) only states non-ultra-hazardous, non-automotive applications as an extended target and expressly excludes ultra-hazardous actives such as aerospace.

## 2.8. Gaps

Martínez-Fernández et al. (2015) found that AUTOSAR practitioners listed several drawbacks to AUTOSAR, including complexity, learning curve, term confusion, and bad documentation. Franco, Neme, Santos, da Rosa, & Dal Fabbro (2016) noted that knowledge about AUTOSAR methodology is not well diffused in academia, which correlates with the lack of academic quality literature discussing it. Many of the articles reviewed made mention of the V-Model. Referring to Appendix H, only Janardhan (2018) attempted to align the AUTOSAR methodology to the V-Model but only where OEM and Tier 1 or 2 suppliers fall within the V-Model. Only two sources reviewed addressed role definitions, and none treated organizational delineations at more than the most abstract levels. Additionally, none of the literature addresses software engineering implications of AUTOSAR, such as right-sizing software components, creating dynamic and self-adapting components with the architectural rigidity of AUTOSAR. Nor does the literature discuss exposing internal software data for development without impacting architecture.

One would have expected the literature to study the AUTOSAR methodology more deeply than was found. For all authoritative sources (theses and dissertations), the methodology was a tool for carrying out their respective studies but was not the subject of any study. Dakermandji (2008) looked at diagnostics. De Bernardo (2019) created a communications stack. Janardhan (2018) examined methods for selecting low-cost tools. Khan (2020) applied Agile methodology to AUTOSAR software development but never discussed the AUTOSAR methodology. Layal (2016) explored creating an ISO 26262 compliant ECU. Moghaddam (2013) investigated multicore AUTOSAR systems. Schreiner (2009) looked into optimizing the RTE through componentization. Finally, Sreeram (2019) worked on the automatic generation of ARXML files. None of these studies specifically examined nor provided a narrative of their use of the AUTOSAR mythology; instead, they introduced the concepts only in general terms.

## 2.9. Summary

A robust set of search criteria was constructed to find literature for review. While many articles and smaller studies were found relating to AUTOSAR methodology, only a single master thesis was located. Secondary searches were performed specifically looking for theses and dissertations about AUTOSAR. Less than 20 total theses and dissertations were located. While nearly every one of them introduced the AUTOSAR methodology somehow, none had the methodology as its primary subject of research. In every case, AUTOSAR was a tool used to conduct the research, but not the subject itself. This lack of detailed examination of the methodology reinforces Franco, Neme, Santos, da Rosa, & Dal Fabbro (2016) that the AUTOSAR standard is not well studied academically.

AUTOSAR began as a partnership of various players in the automotive industry in 2003. By 2005 a formal standard for software architecture was released. This standard prescribed a methodology that specifies specific high-level steps to develop AUTOSAR compliant software. As highlighted by Martínez-Fernández et al. (2015) and Franco, Neme, Santos, da Rosa, & Dal Fabbro (2016), there is much about AUTSOAR that has yet to be academically studied. There is disagreement within the automotive industry and between the automotive industry and academia about what it is, how it is applied, and how useful it is. This study proposed expanding on the work of Martínez-Fernández et al. (2015) by exploring how AUTOSAR practitioners do their work. It questioned where practices are similar and where they are dissimilar. Where are organizations delineated both externally and externally? How are organizations staffed, how are their software components sized and managed? How many components? How many compositions? How many Architects? Answering these and many other questions will help further the practice and increase the AUTOSAR body of knowledge.

# CHAPTER 3: METHODOLOGY

## 3.1. Rationale

The literature reinforces that AUTOSAR is a robust software architecture for the automotive industry. Although developed to address the needs of the automotive software development ecosystem, the AUTOSAR methodology specification fails to specifically relate to the most prevalent software development process model, the V-Model. Much of the literature examining the AUTOSAR application mentioned the V-Model but failed to address how AUTOSAR practitioners align with the V-Model systematically. Of the literature reviewed, only Martínez-Fernández et al. (2015) conducted a survey-based study. However, it was limited to only asking about the perceived benefits and drawbacks of AUTOSAR in general. This research expanded on the work of Martínez-Fernández et al. and explored how AUTOSAR practicioners go about the business of implementing AUTOSAR. With the assistance of the AUTOSAR organization, practitioners of the AUTOSAR methodology were recruited to participate in an Internet base survey that asked questions on personal and company demographics and their use of AUTOSAR.

## 3.2. Research Design

This research provided results that AUTOSAR practitioners can use to guide the implementation of AUTOSAR methodology. This study was a single survey of AUTOSAR practitioners constructed of questions to gather quantitative and qualitative data, based on a sampling framework developed by DeMello and Travassos (2016). Quantitative data were numerical values, while qualitative data obtained from open-ended questions was not readily quantifiable (Sekaran & Bougie, 2016, p. 2). Martínez-Fernández et al advertised their study at select conferences and two AUTOSAR specific LinkedIn groups. Enlisting the AUTOSAR organization to recruit participants for this study helped to increase overall participation. The official AUTOSAR LinkedIn group and a mass emailing of the AUTOSAR partners were the communication channels utilized.

## 3.3. Sample

Surveys in software engineering are known to have difficulty obtaining representative samples. This difficulty results from the use of convenience sampling, lacking external validity, impartiality, and representativeness (de Mello & Travassos, 2016; de Mello, 2016). To combat this, de Mello and Travassos developed a framework consisting of eight concepts and various activities to facilitate the design and planning to improve validity. This study utilized this sampling framework.

### 3.3.1 Target Audience/Population

De Mello and Travassos (2016) described the target audience as identifying those who can provide the data needed to answer the research question. The research questions of this study were related to the AUTOSAR methodology, which meant that those individuals practicing the AUTOSAR methodology were the target population. These practitioners included OEMs, Tier 1 Suppliers, Tier 2 Suppliers, and Vendors.

### 3.3.2 Subject

The survey subjects, or respondents, were primarily involved in developing AUTOSAR software and tools, including software engineers, mechanical engineers, controls engineers, leaders and managers, architects, testers, integrators, process owners, and tools developers. These subjects possessed a range of experience, education levels, and expertise.

### 3.3.3 Unit of Analysis

de Mello and Travassos defined the unit of analysis as the “primary entity used for analyzing the study” and can be individuals or groups (2016, p. 3). The data unit of analysis was AUTOSAR practitioners divided into the roles of OEMs, Tier 1 Suppliers, Tier 2 Suppliers, and Vendors; or by application (domains) the practitioners employed AUTOSAR Methodology for ADAS, Body Comfort, Chassis, HMI, Multimedia, Occupant and Pedestrian Safety, Powertrain, Safety (Vehicle), Telematics, Non-Automotive, and other. The survey also included non-identifiable individual demographic questions to understand the respondents' backgrounds, allowing for comparison to results of similar questions posed by the Martínez-Fernández et al. study.

### 3.3.4 Source of Population

de Mello and Travassos (2016) prescribed identifying the sources of populations from which to draw samples. For this study, the source of the population was the collective body of AUTOSAR practitioners identified as AUTOSAR Partners and self-subscribed members of the official AUTOSAR LinkedIn group.

### 3.3.5 Population Search Plan

The de Mello and Travassos (2016) framework required a set of guidelines for retrieving an adequate population from the identified sources. However, as highlighted by several studies, obtaining a representative sample from this population is difficult (Martínez-Fernández, Ayala, Franch, & Nakagawa, 2015; de Mello, 2016; de Mello & Travassos, 2016). This problem with obtaining representative samples often arises because studies related to software engineering practices use convenience sampling. There is a lack of control over who receives the surveys, and there is a generally low response rate in the software engineering field. The AUTOSAR organization assisted by helping recruit participants of the survey by sending an email to the AUTOSAR Partners and posting to the official AUTOSAR LinkedIn group.

### 3.3.6 Sampling Frame

de Mello and Travassos (2016) prescribed the listing of units in the form of a sampling frame, defined as specifically identifying the source of the samples, as part of the sampling framework. The AUTOSAR organization, LinkedIn, and professional contacts were the primary source of the population. That said, AUTOSAR listed 9 Core Partners, 2 Strategic Partners, 55 Premium Partners, 51 Development Partners, 143 Associate Partners, 24 Attendees, 139 Vendors (AUTOSAR, 2020c; AUTOSAR, 2020f; AUTOSAR, 2020e; AUTOSAR, 2020d; AUTOSAR, 2020a; AUTOSAR, 2020b; AUTOSAR, 2020g). Inferring the minimum number of AUTOSAR practitioners was necessary as it was impossible to determine the global AUTOSAR practitioners accurately. The AUTOSAR LinkedIn page listed 1754 followers (LinkedIn, 2020b). There were 40 groups found when searching for “AUTOSAR.” and the AUTOSAR LinkedIn group (LinkedIn, 2020a) listed 7,187 members, which was an increase from the “around 5000” reported by Martínez-Fernández et al. (2015, p. 21). The Model-Based Software Engineering group boasted 9,517 while the AUTOMOTIVE SYSTEMS ENGINEERS group listed 2883, and the remaining groups each had less than 700 members (LinkedIn, 2020a). Martínez-Fernández et al. reported two distinct AUTOSAR LinkedIn groups: “AUTOSAR” and “Autosar.” However, in the five years since, only a single group titled AUTOSAR, regardless of capitalization, could be located (2015, p. 21). Martínez-Fernández et al. provided no citation for the LinkedIn groups, so it is impossible to know for certain. However, the most likely explanation for this discrepancy is the deletion of one or merging the two groups. The population of AUTOSAR practitioners is estimated to be at least 7,000 based on the memberships found during the LinkedIn group search.

### 3.3.7 Sampling Strategy

de Mello and Travassos (2016) suggested describing the sampling strategy, including the sample size in their conceptual framework. It was impossible to accurately quantify the number of individual AUTOSAR practitioners globally, but as suggested in section 3.3.6 Sampling Frame, it is considered at least 7,000. With this approximated population of global AUTOSAR practitioners, determining the appropriate sample size followed. Taherdoost (2017) told us there are numerous ways to calculate the required sample size, most of which involve the desired confidence level and maximum error along with estimations of variance and gave us the formula $n = p\ (100-p)z2/E2$ (2017, p. 237). With a confidence level of 95, a 5 percent margin of error, and a 50% proportion, the required sample size was 384. Sekaran and Bougie (2016) similarly proposed to calculate sample size based on confidence and proportion and provided a table of select population sizes and sample sizes, which specified a sample size of 364 for a population size of 7,000 (2016, pp. 236-264). The question then was whether this study could obtain a sufficient sample size. Sekaran and Bougie give six factors that affect one’s decisions on sample size (2016, p. 241):

a) The research objective

b) The extent of precision desired (the confidence interval)

c) The acceptable risk in predicting the level of precision (confidence level)

d) The amount of variability in the population itself

e) The cost and time constraints

f) In some cases, the size of the population itself

Martínez-Fernández et al. (2015) reported 51 valid responses out of an estimated minimum population of 6,000 for a response rate of 0.85%, assuming the same response rate; this study would expect a similar result. A follow up in-person meeting was held with Dr. Martínez-Fernández, who stated the total unfiltered responses for his study was 90, which was an unfiltered response rate of 1.5% (S. Martínez-Fernández, personal communication, December 22, 2020). Contacting potential subjects was conducted similarly to that of Martínez-Fernández et al. (2015), and de Mello (2016). The AUTOSAR organization sent recruitment emails to its membership and advertised in the official AUTOSAR LinkedIn Groups with the hashtags #autosarenthusiasts, #autosar, #classicplatform, #adaptiveplatform, #automotive, #standardization, #futuremobility, and #innovation. Whereas Martínez-Fernández et al. took advantage of conferences to announce their study, this study leveraged the AUTOSAR organization with professional contacts to help advertise the survey. The final number of responses to this study was 152 and a response rate of 2.1%, raising concerns for the validity of the results; however, studies in software engineering often have difficulty with response rates (de Mello & Travassos, 2016). Enlisting the AUTOSAR organization to recruit study participants helped improve the number of responses collected compared to that of Martínez-Fernández.

### 3.3.9 Sample Characterization Questions

The last concept of the de Mello and Travossos (2016) sampling framework was developing a series of questions to characterize the subjects included in the sample. The subjects of this study were AUTOSAR practitioners that are either OEMs, Tier 1 or 2 Suppliers, and Vendors. A number of the survey questions asked respondents for specific demographic questions designed to replicate Martínez-Fernández, Ayala, Franch, & Nakagawa (2015).

## 3.5. Data collection

Sekaran and Bougie (2016) explained that researchers on occasion employ mixed methods, which is to say using more than one research method. However, this study relied solely on the data collected from the Internet-based survey, which consisted of questions designed to elicit qualitative and quantitative responses. The goal of the survey was twofold: to answer the research questions and compare demographic responses to that of Martínez-Fernández et al. (2015). Utilizing the Purdue University instance of the Qualtrics internet-based survey system, the Internet-based survey was conducted and provided in English, German, Japanese, and Simplified Chinese. Google Translate provided the direct translations, and the AUTOSAR organization assisted with verifying the translations. Storing the data in a secure system maintained the integrity of the data and ensured a backup was maintained to prevent data loss.

### 3.5.1. Instrumentation and Validation

Referring to Appendix G, the survey was designed to answer the three research questions while replicating portions of the methodology from Martínez-Fernández et al. (2015). The survey consisted of four sections relating to demographics, practice, and perceptions of AUTOSAR methodology. The first section asked three questions relating to the respondent's company demographics. The second section was RQ1 and RQ2. The third section consisted of 14 questions concerning the respondent's AUTOSAR methodology, including how many architects are employed, sized applications, workflows, and standards support. The fourth section contained five personal demographics of the respondent and a final open-ended question designed to elicit open feedback. The survey questions were validated through peer review by professional contacts with extensive experience in AUTOSAR and the AUTOSAR organization. The AUTOSAR organization also assisted with validating the translations of the survey questions. Replicating many of the questions about demographics from the Martínez-Fernández et al. study (2015) allowed for a comparison of the demographic analysis conducted by Martínez-Fernández. Collaboration with the AUTOSAR organization and other colleagues aided in designing the non-demographic questions based on recent experiences implementing a new AUTOSAR development program from scratch.

# CHAPTER 4: DATA ANALYSIS

The Internet-based survey was launched on November 9, 2021, and was open for two weeks. The survey system used was the Purdue University instance of Qualtrics. The survey contained 25 optional questions, a combination of multiple-choice and short answers. The survey received 152 responses, of which 52 clicked through to completion, and 13 answered all 25 questions. Exploration of the data included simple statistics and a mixture of histograms, box plots, word clouds, and geographical plots to visualize the global reach of AUTOSAR. After downloading the data from Qualtrics as comma-separated values (CSV), Matlab R2020a was then used to analyze the survey responses. A custom Matlab script loaded the survey data from the CSV file into a table object, and data processing precluded unanswered questions from inclusion in the analysis. Google Translate translated the answers provided in a language other than English. Since there were few responses to short answer questions, only one question required coding, Q3.11, and is discussed in detail in the analysis for that question. A complete reporting of all other short answer responses in their entirety follows the detailed analysis for each question below.

### Q1.1 Country of Company Headquarters

This question aimed to understand where the companies that practice AUTOSAR, a global standard, are located. A Qualtrics provided built-in dropdown selection list presented the list of countries for the participant to select. Of the 152 total samples, 85 were answered and included in the analysis of this question for a 56% response rate. See Figure 8 for the data summary. Germany had the highest representation at 24, India second at 17 and China third with 12. The responses to this question are what was expected given AUTOSAR was initiated by German automotive companies.

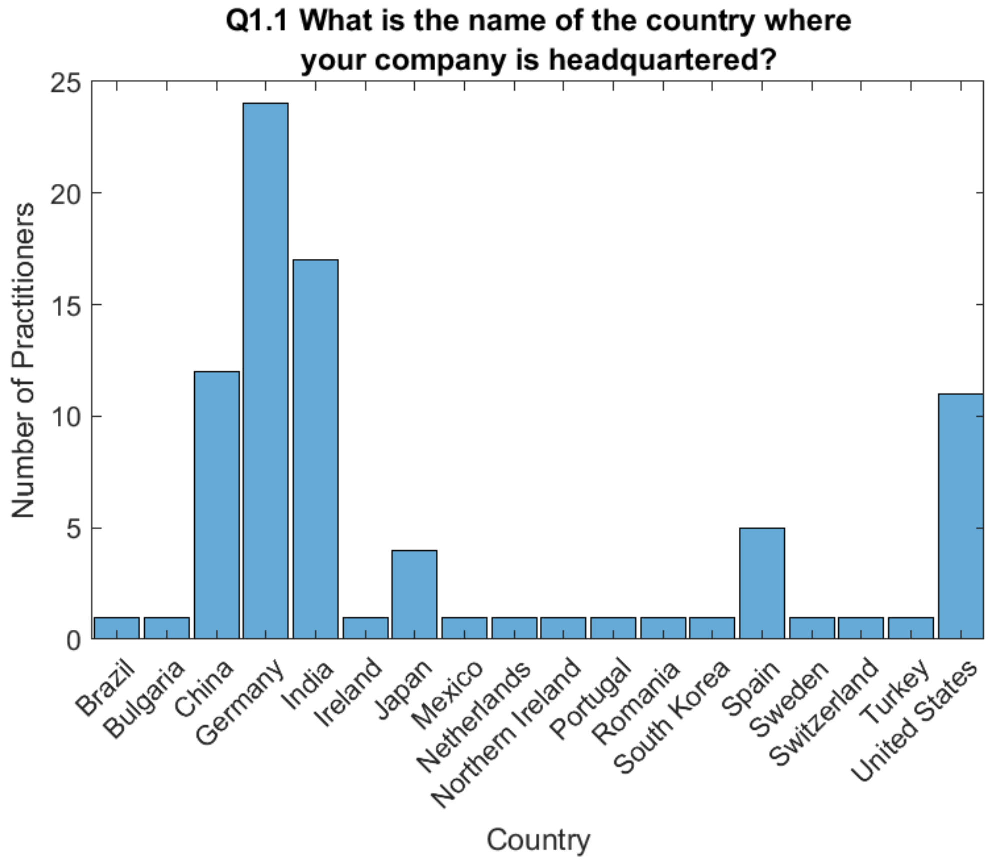



**Figure 8**

*Company Countries*

**Q1.2 Years of Company Experience**

The purpose of the question was to ascertain the general level of experience of companies practicing AUTOSAR. Figure 9 presents a series of boxplots of the years of experience for the respondent's companies overall and by company role. Of the 152 total samples, 82 answered this question for a 54% response rate. The minimum number of years was zero. The maximum number of years was 21 years. The mean number of years was 9.5, the median was 10 years, the range was 21 years, and the standard deviation was 5.8 years. Outliers in the upper end of years likely represent companies that have been involved with AUTOSAR since its inception. The average is less than ten years and suggests either use of AUTOSAR has grown or there has been a loss of more experienced companies.


**Figure 9**

*Company Experience by Role*

### Q1.3 AUTOSAR Role of Company

The purpose of this question was to ascertain the number of companies filling the various roles within AUTOSAR. Options provided were OEM, Tier 1 Supplier, Tier 2 Supplier, Tool Developer, New Market Entrant, and Other. Users could only select one option, and a free text field allowed for short answers for "Other." With Figure 10 visualizing the data, from the 152 total samples, 87 answered this question for a 57% response rate. There were more Tier 1 and Tier 2 Suppliers than OEMs, Tool Developers combined, which would be expected given the intent of AUTOSAR is to enable OEMs to purchase software from suppliers. User-provided comments for 'Other' were 'Development Service Provider,' 'Engineering Service Provider,' 'Tire 1', 'Tire2', 'AUTOSAR software supplier,' and 'CETools supplier.`

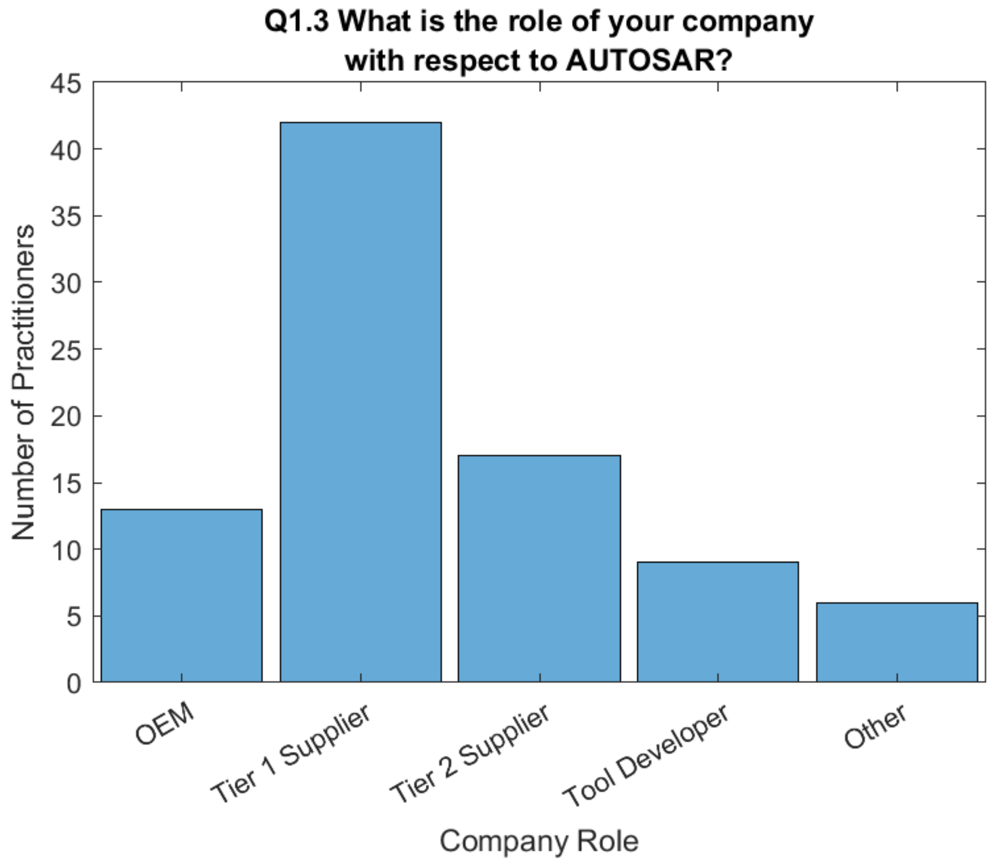



**Figure 10**

*Company Role in AUTOSAR*

**Q2.1 AUTOSAR Facilitation**

This question was the first of the stated research questions for this study. Options given to the respondent were `Specifies what information needs to be exchanged between steps,` `Separates application development from base software,` `Separates hardware from software,' ‘Defines work products and contents,' and ‘Other/Comments.' User provided comments for `Other' were:

- "Defines general / generic software architecture for ECUs."
- "Standardized BSW supports combination of BSW products from different vendors"

- “Some groups have attempted to keep the existing processes, modify them slightly, and relabel them as AUTOSAR.  Not all groups, but some. In the big picture, the AUTOSAR levels have been split into different organizations.”
- Unfortunately, not much yet. The idea that AUTOSAR can provide more support than an additional burden is only slowly gaining ground. The resistance to replacing legacy code with AUTOSAR is high among most employees.
- It is really complicated. Most of engineers think current AUTOSAR methodology and toolchain cause more time to develop the software.

As illustrated in Figure 11, of the 152 total samples, 77 were answered for a 51% response rate. Figure 12 shows the data by company role..  In general respondents indicated that the separation of the hardware/software and application/base software facilitated their application of AUTOSAR the most.

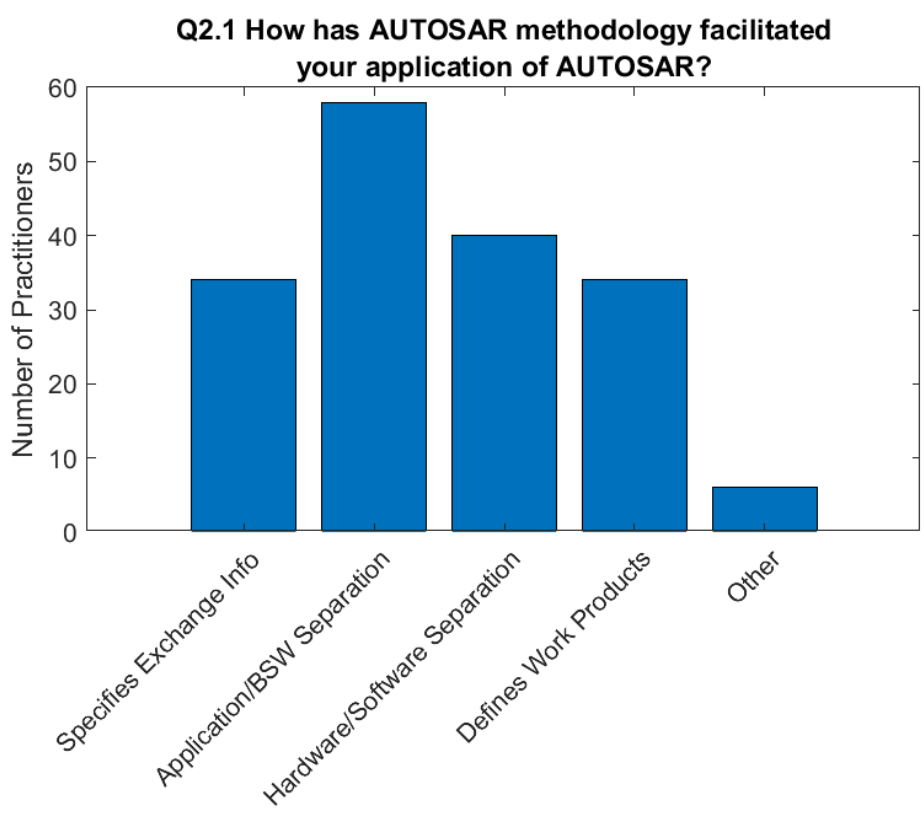



**Figure 11**

*How AUTOSAR has facilitated*

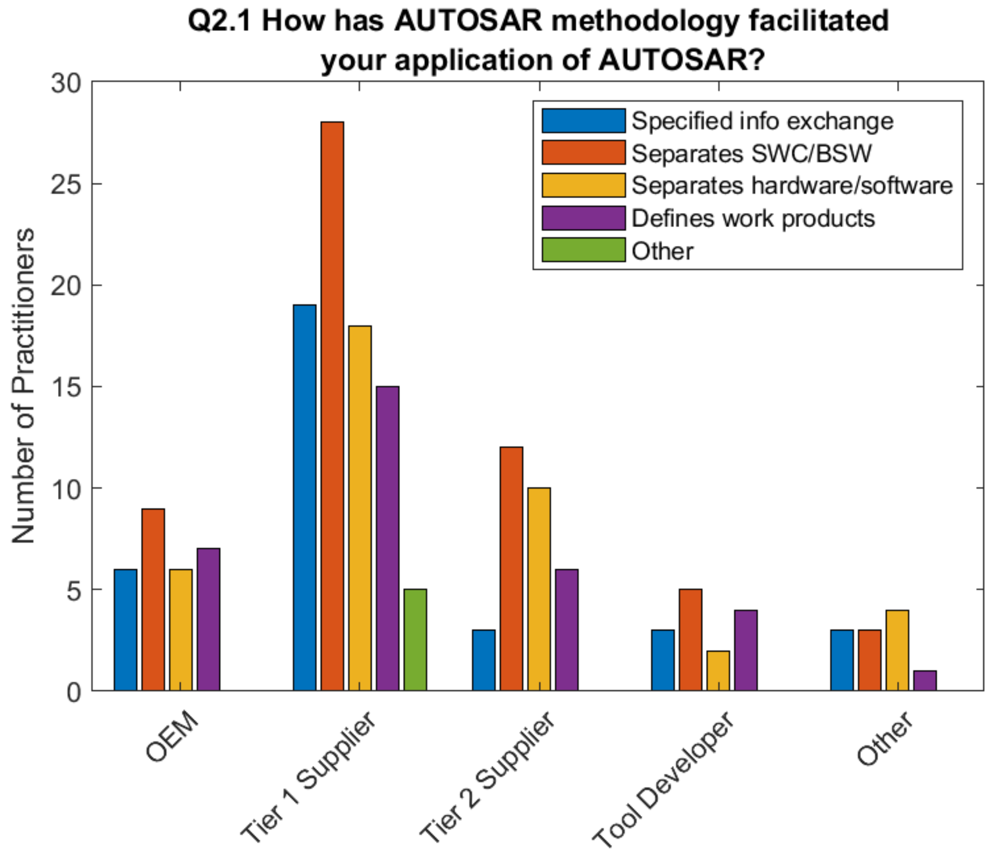



**Figure 12**

*How AUTOSAR Facilitates by Role*

### Q2.2 AUTOSAR Impedance

This question was the second of the stated research questions for this study. Options given to the respondent were 'Does not define specific processes,' 'None,' 'Does not specify a timeline,' 'Interface specifications are not sufficient for precise modeling,' 'Does not define roles and responsibilities,' and 'Other/Comments.' User provided comments for `Other' were:

- "Separation of generic / reusable basic software from product and project-specific parts in the Autosar stack configuration is not possible without additional features (e.g. "splittable configuration"). Functionally simple changes (e.g. new CAN signal) require multiple configuration changes to several modules, which are then difficult to understand"
- "Many people consider it "outdated" now"

- “AUTOSAR ARXML format is complex and its very often unclear what kind of configurations are a valid model”
- “To many unknowns to leave implementers to their own "devices" without a rigid structure. Lots of options lead to confusion on what is the best option”
- The main reason is general resistance, but the points above are also part of the reason.
- Application of industry standards, such as SAE J1939, is very limited.
-

As shown in Figure 13, of the 152 total samples, 77 were answered for a 51% response rate. Figure 14 shows the data by company role. Respondents indicated that the lack of support for precise modeling impedes their application of AUTOSAR, though only slightly more than the other options. This finding is consistent with that of Broy et al. (2007).

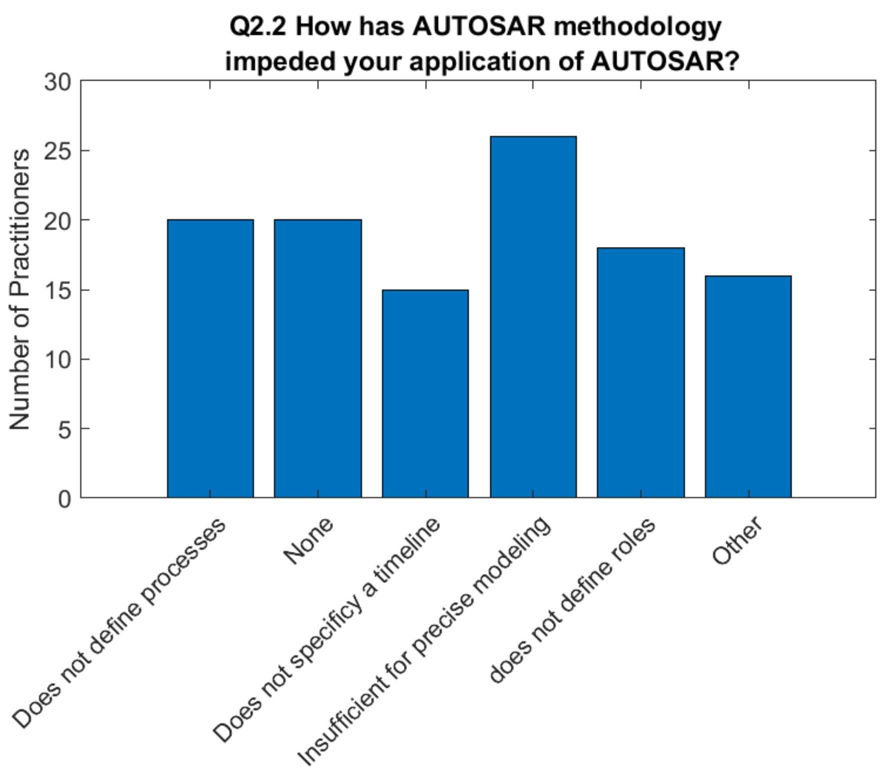



**Figure 13**

*How AUTOSAR has Impeded*

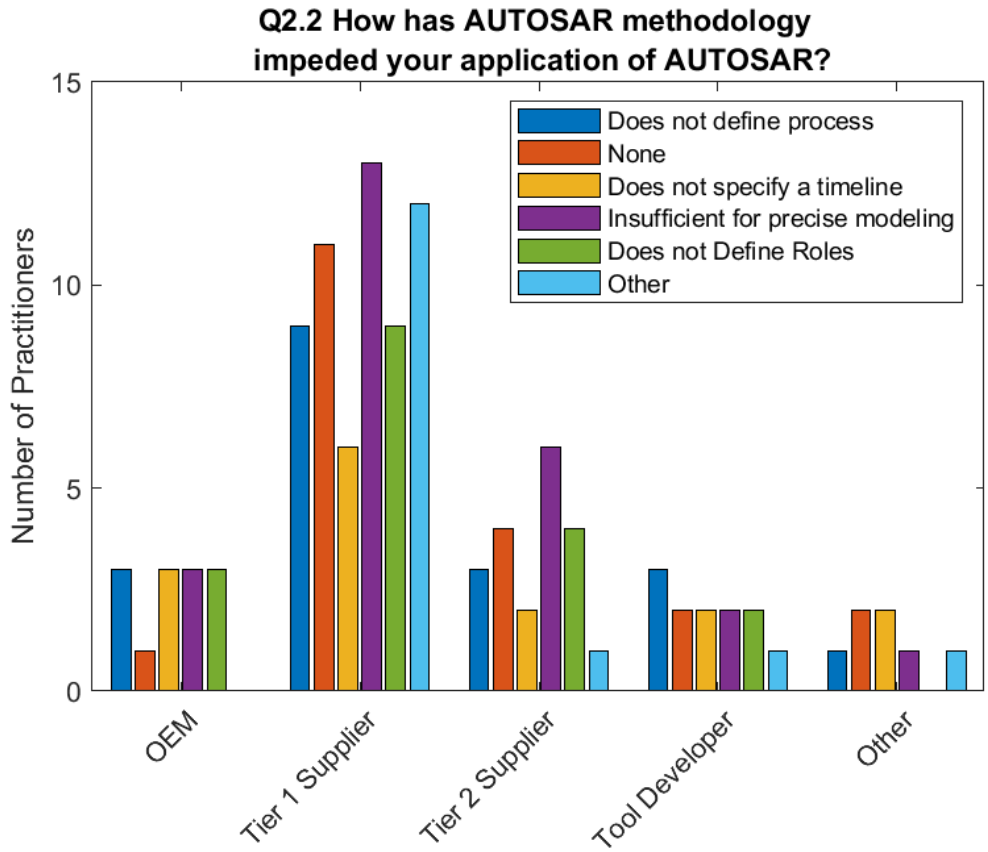



**Figure 14**

*How AUTOSAR Impedes by Company Role*

### Q3.1 AUTOSAR Workflows

The purpose of this question was to ascertain what workflows practitioners use with AUTOSAR. Options provided were ‘Top-Down,’ ‘Bottom-Up,’ and ‘Other.’ Users were free to select any option desired. ‘Other’ allowed the user to provide a comment. User-provided comments for ‘Other’ were:

- ‘Mixed way’
- ‘We claim Top-Down, but the actual deliveries so far seem kind of Middle-Out’

As shown in Figure 15, from the 152 total samples, 48 were answered for a 32% response rate. There were just as many respondents indicating the use of Top-Down as Bottom-up, suggesting perhaps neither workflow is optimal and the decision for which to utilize is situationally driven.  The responses suggested that practitioners do not employ any single workflow and did match what was expected

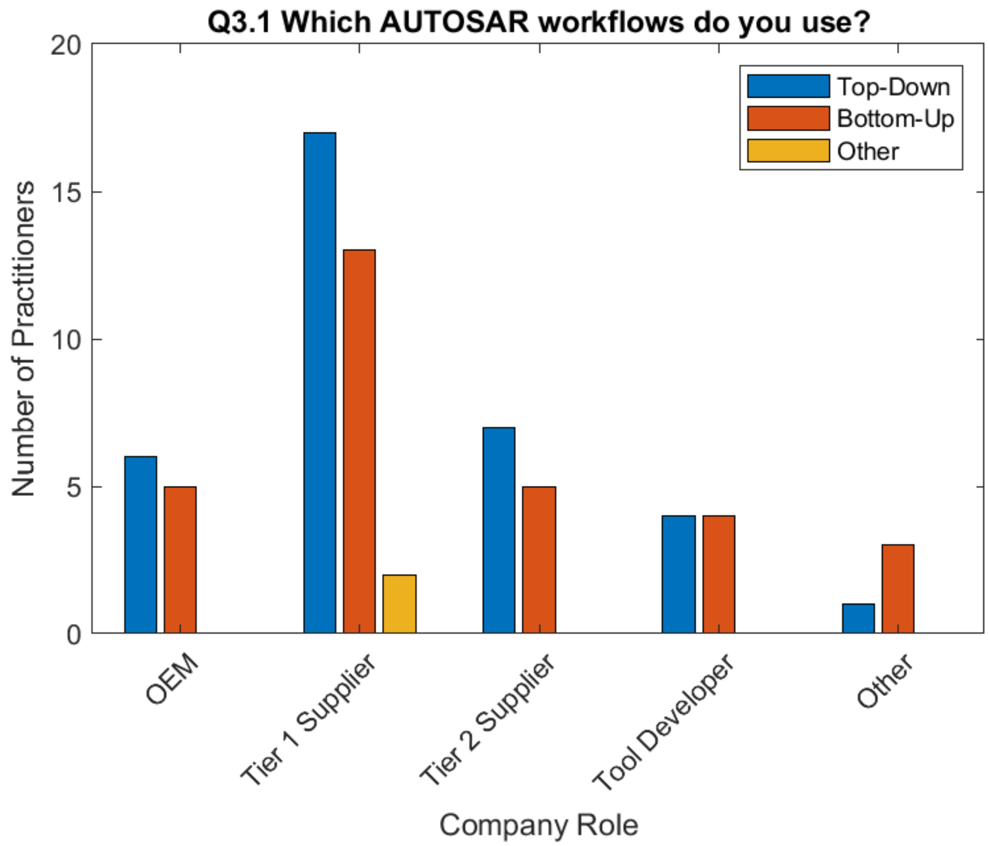



**Figure 15**

*Workflows by Company Role*

**Q3.2 Supplied Vs In-House?**

The purpose of this question was to ascertain what workflows practitioners use with AUTOSAR.  Options provided were `0-25%', '26-50%', '51-75%, and '76-100%'.  Responses were limited to a single option.  There were 48 answers given out of the 152 responses for this question for a 32% response rate.  The data indicated that most practitioners are as likely to develop in-house as source externally.  This finding was surprising since it was expected there would be much more buying and selling of software components.  A likely explanation could be the purchasing of the base software while developing application software components in-house. Figure 16 shows the data by company role.

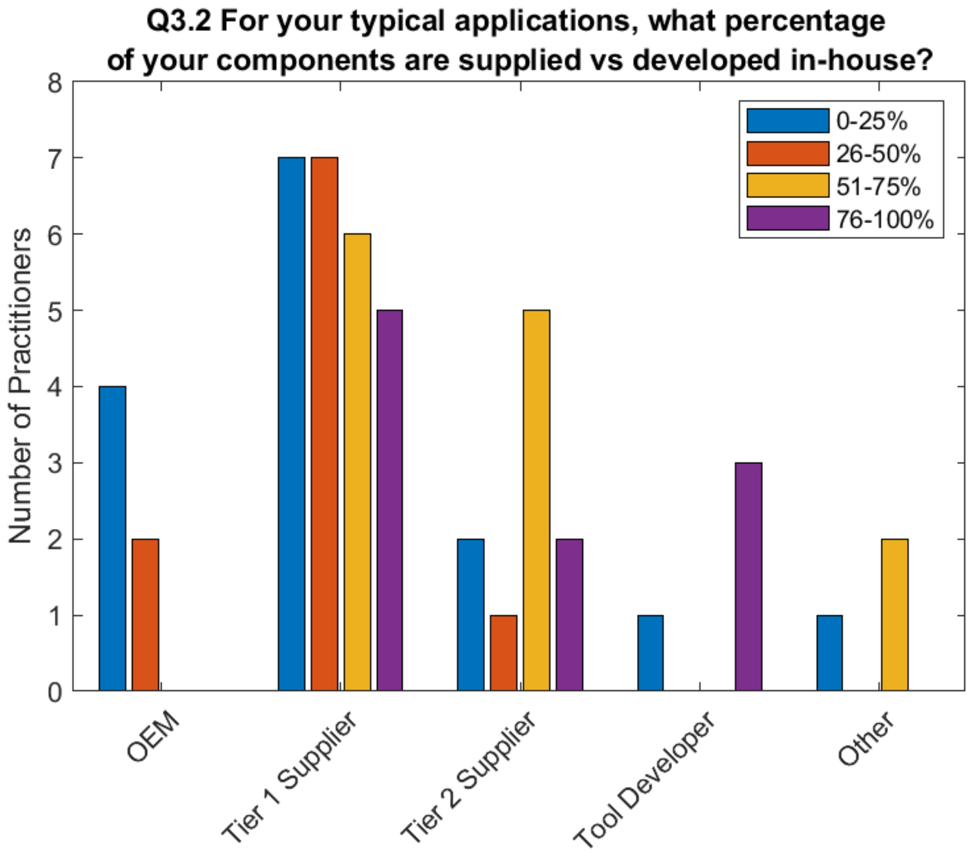



**Figure 16**

*Supplied vs. Developed by Company Role*

### Q3.3 System Skeleton Generation

The purpose of this question was to ascertain when practitioners generate system skeletons. Options provided were `After the architecture is fully defined (contract phase),' 'After the composition interfaces are defined,' 'After the component interfaces are defined,' and 'Other.' Responses were limited to a single option. User-provided comments for 'Other' were:

- "Because mostly system_new_developments, usually the result Iterative development."
- "During system specification process"
- "Frequent update during project life time"
- "We generate the RTE and use it for component development."
- "It's an iteration process"

- “Do not use RTE, only BSW Elements”

From the 152 total samples, 48 respondents responded with a 32% response rate. The responses indicate that most practitioners do not generate system skeletons after fully defining the components but instead at the contract phase or after defining compositions. This finding matched expectations. Two of the provided comments indicated that those respondents generate the system skeleton iteratively. Figure 17 shows the data by company role.

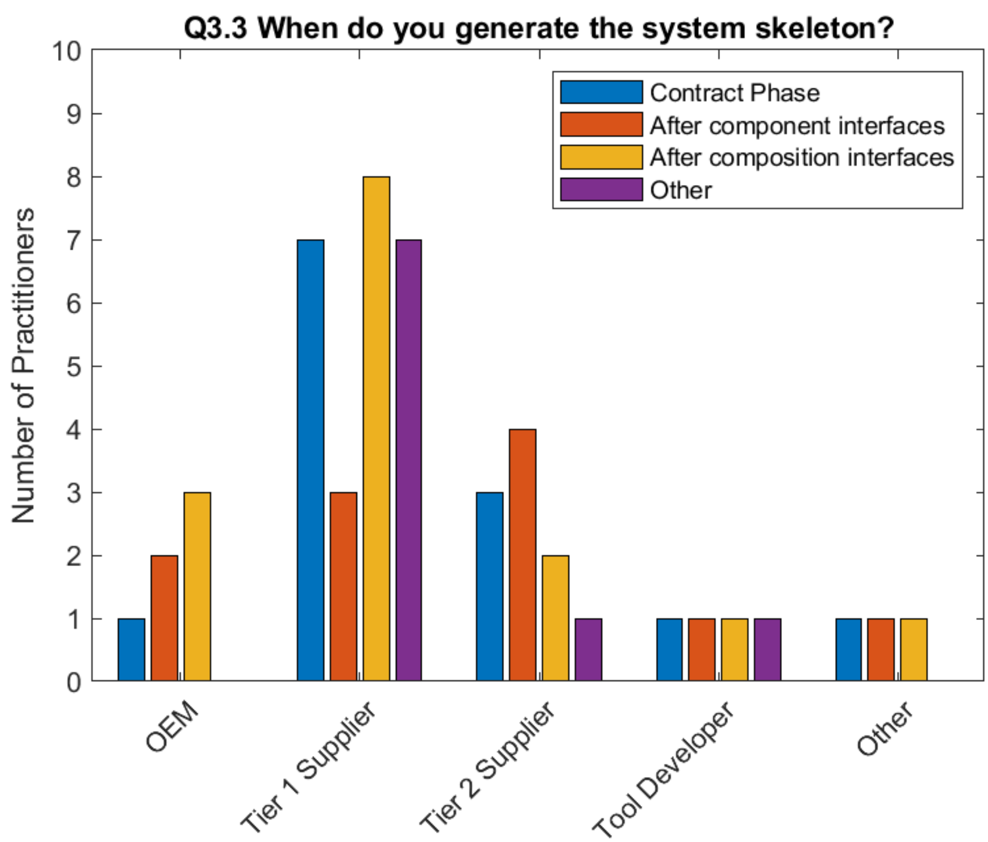



**Figure 17**

*System Skeleton by Company Role*

**Q3.4 Runtime Environment Generation**

The purpose of this question was to ascertain when practitioners generate the RTE. Options provided were `After the architecture is fully defined (contract phase),’ ‘After the composition interfaces are defined,' 'After the component interfaces are defined,' and 'Other.' Responses were limited to a single option. User-provided comments for 'Other' were:

- "The RTE is generated automatically in a continuous integration chain"
- "While building"
- "Frequent update during project life time"
- "two steps 1. contract phase and final when components defined with all service ports from BSW as well"
- "We generate the RTE and use it for component development."
- "Continuous updates over the project phase"
- "all the time"
- Do not use RTE, only BSW Elements

With the 152 total samples, 47 respondents answered for a 31% response rate. Most practitioners generate the RTE after the component architecture is defined, but very few generate the RTE at the contract phase, and even fewer after compositions are defined. This finding was surprising because the practitioners were expected to generate the RTE frequently. The open comments suggest that some practitioners generate the RTE frequently during project development. Figure 18 shows the data broken down by company role.

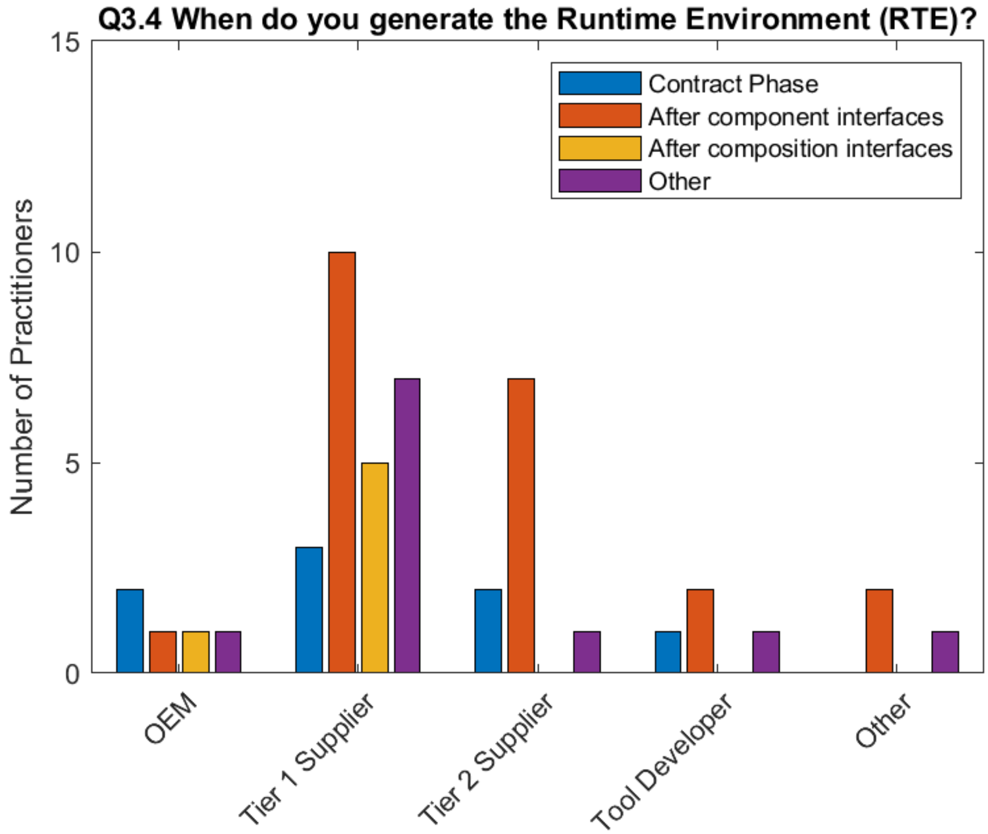



**Figure 18**

*Generating the Runtime Environment by Company Role*

### Q3.5 Architect Deployment

The purpose of this question was to understand how companies approach team structure concerning architects. With the 152 total samples, 45 respondents for a 30% response rate. The maximum value was 250 architects, the minimum was 0 architects, the mean was 28.4 architects, the median was 10 architects, the range was 250 architects, and the standard deviation was 47.9 architects. Boxplots in Figure 19 allowed for examining the number of architects per company role. The boxplot shows that the number of architects was consistent for all company roles except for tool developers. The number of architects was also examined by application type via boxplot in Figure 20, highlighting variation between the different AUTOSAR applications. The data shows that while most respondents reported 40 or fewer architects, there were extremes of

100, 150, and 200. These extremes were quite surprising and could indicate respondents did not limit their answers to the number of AUTOSAR architects.

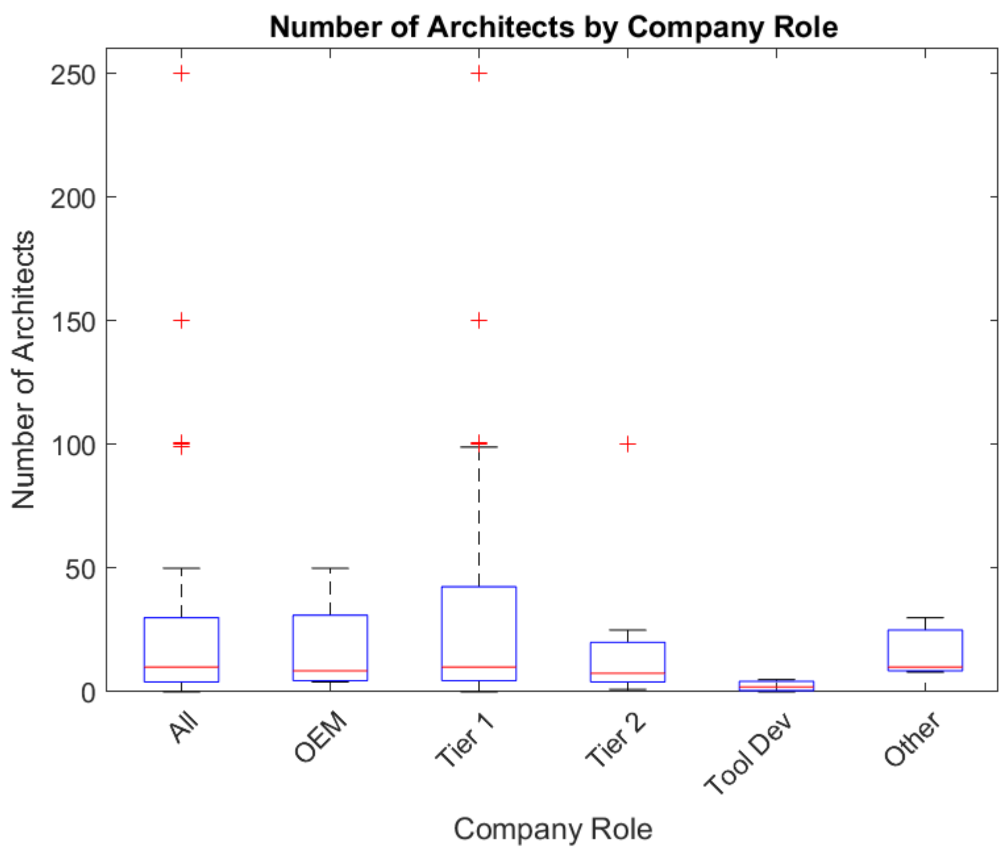



**Figure 19**

*Number of Architects by Company Role*

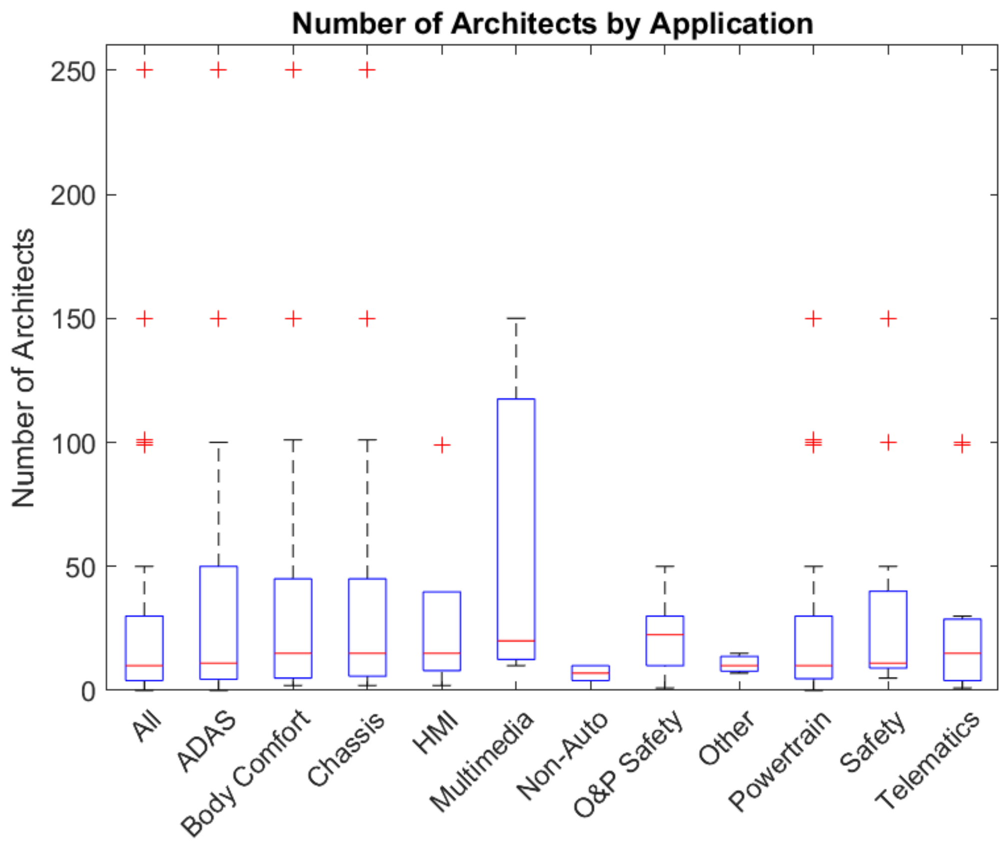



**Figure 20**

*Number of Architects by Application*

**Q3.6 How are architects deployed within your organization?**

The purpose of this question was to ascertain how companies deploy AUTOSAR architects within their organizations. Options provided were `All on the same team,' 'Split amongst the system and component teams,' and 'Other.' Responses were limited to a single option. User-provided comments for 'Other' were:

- "One for each SW project. Big projects, have a hierarchy of SW architects"
- "split over central teams for system and component design and teams belonging to specific projects"
- "Divided into system and software. However, the system largely ignores AUTOSAR."
- "One architect per DevTeam (4-7 developers) + architects on staff positions"

Of the 152 total samples, 49 respondents responded with a 32% response rate. As shown in Figure 31, the data shows companies are more likely to split their AUTOSAR architects amongst teams, which matches what was expected.

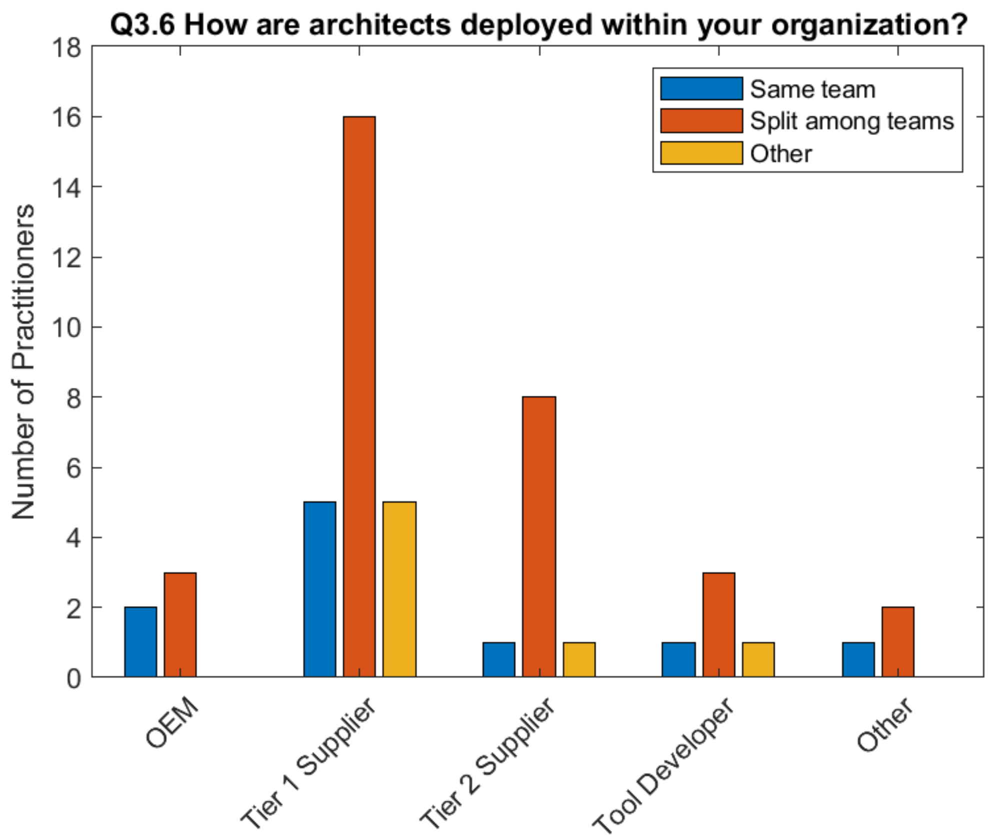



**Figure 21**

*Architect Deployment by Company Role*

**Q3.7 Component Count**

The purpose of this question was to ascertain how practitioners size their AUTOSAR applications. Respondents answered in a single input field which limited responses to numeric values. From the 152 total samples, 46 respondents answered for a 30 percent response rate. The maximum number of components was 1,000, the minimum was 0 components, the mean was 118.4 components, the median was 30 components, the range was 1,000 components, and the standard deviation was 225.4 components. The boxplots in Figure 22 show the data broke down by company role, while Figure 23 does so by application type. The finding of an average of 118 components was slightly below expectation. The data showed extreme outliers, with some respondents reporting 300, 400, 500, and 1,000 were surprising, which could indicate that practitioners have misapplied the AUTOSAR methodology or over-composed their software.

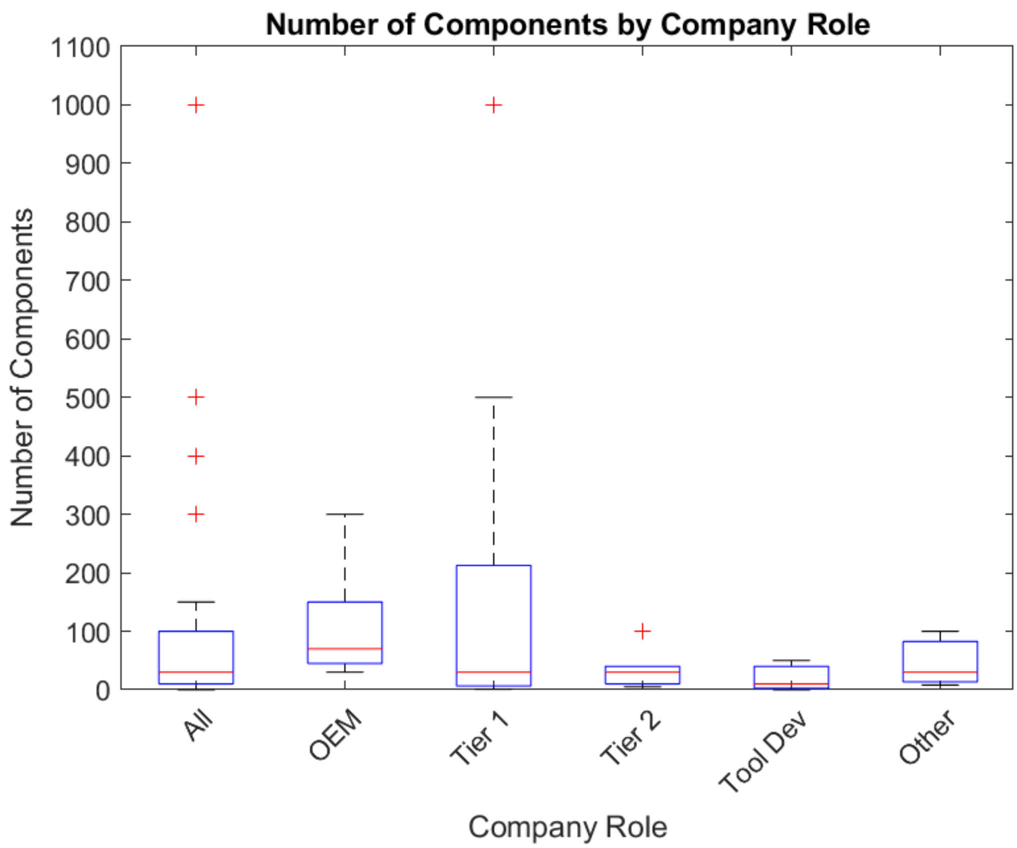



**Figure 22**

*Number of Components by Company Role*

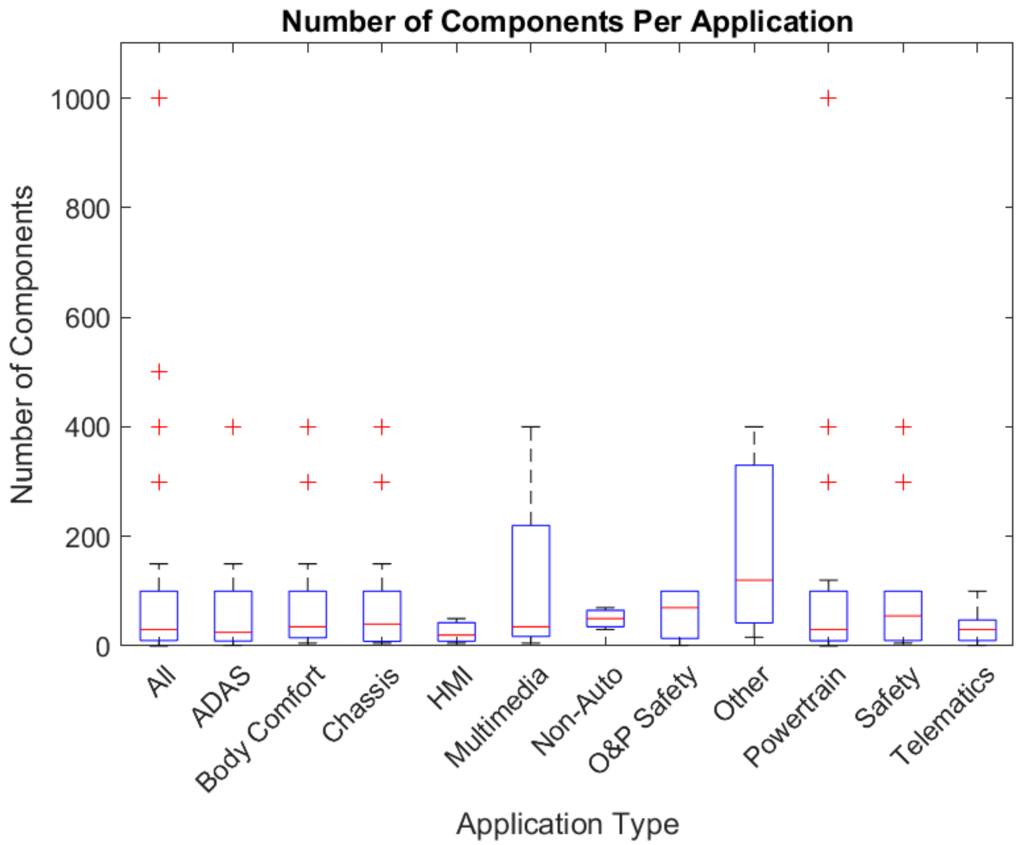



**Figure 23**

*Number of Components by Application Type*

**Q3.8 Composition Count**

The purpose of this question was to ascertain how practitioners size their AUTOSAR applications. Respondents answered in a single input field which limited responses to numeric values. Of the 152 total samples, 43 respondents answered for a 28% response rate. The maximum number of compositions was 100, the minimum was 0 compositions, the mean was 14.2 compositions, the median was five compositions, the range was 100 compositions, and the standard deviation was 25.2 compositions. This finding aligned with expectations. Fewer outliers were highlighted by the boxplots in Figures 24 and 25 as opposed to those identified in the number of components. Nonetheless, 100 compared to the average of 14 is noteworthy.

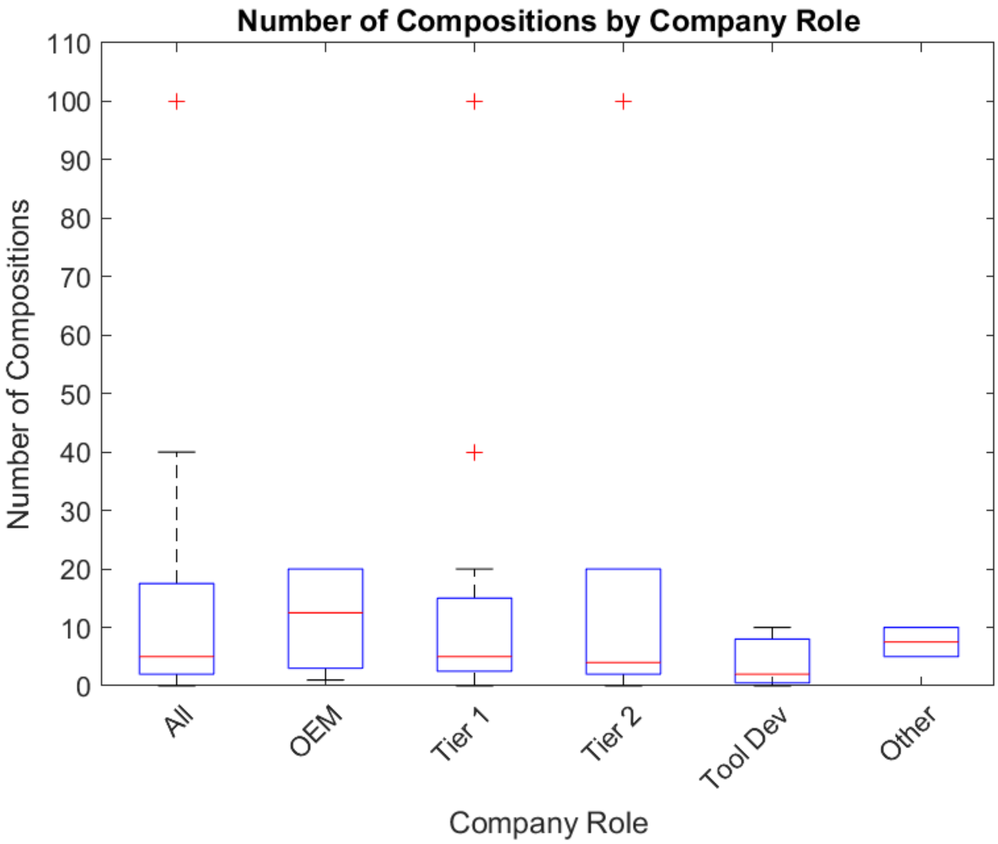



**Figure 24**

*Number of Compositions by Company Type*

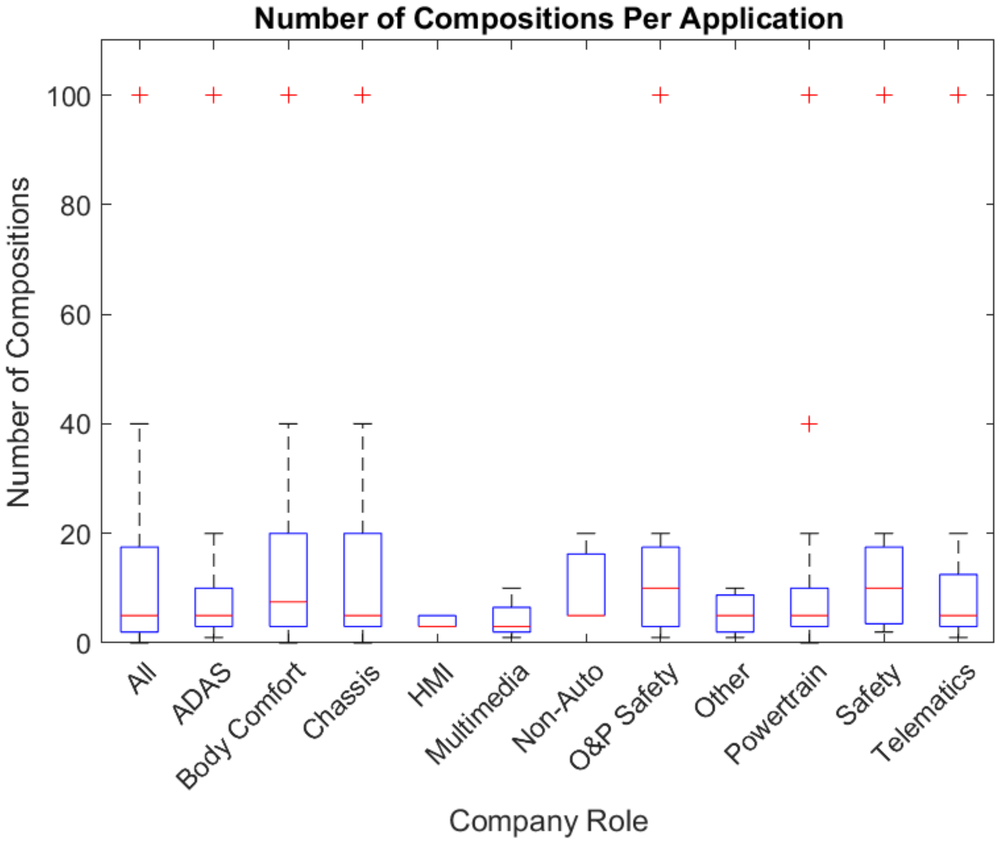



**Figure 25**

*Number of Compositions by Application*

### Q3.9 Application Types

The purpose of this question was to understand the sorts of applications AUTOSAR practitioners develop using the AUTOSAR Methodology. Options provided were 'ADAS', 'Body Comfort', 'Chassis', 'Human Machine Interface (HMI)', 'Multimedia', 'Occupant and Pedestrian Safety', 'Powertrain', 'Safety (ABS, Airbag, etc)', 'Telematics', 'Non-Automotive' (with free form comment), and 'Other'. Users were free to select any option desired. There was one non-automotive application reported. The sole user-provided comment for non-automotive was: “Power System Distribution.” User-provided comments for ‘Other’ were:

- “Power System Distribution”
- “eMobilty components: OBC and BMS”

- “Engine”

Out of the 152 total samples, 48 responses were given for a response rate of 32%. There were more practitioners developing powertrain applications, followed by ADAS. This finding was expected. Figure 26 shows the reported applications by company role.

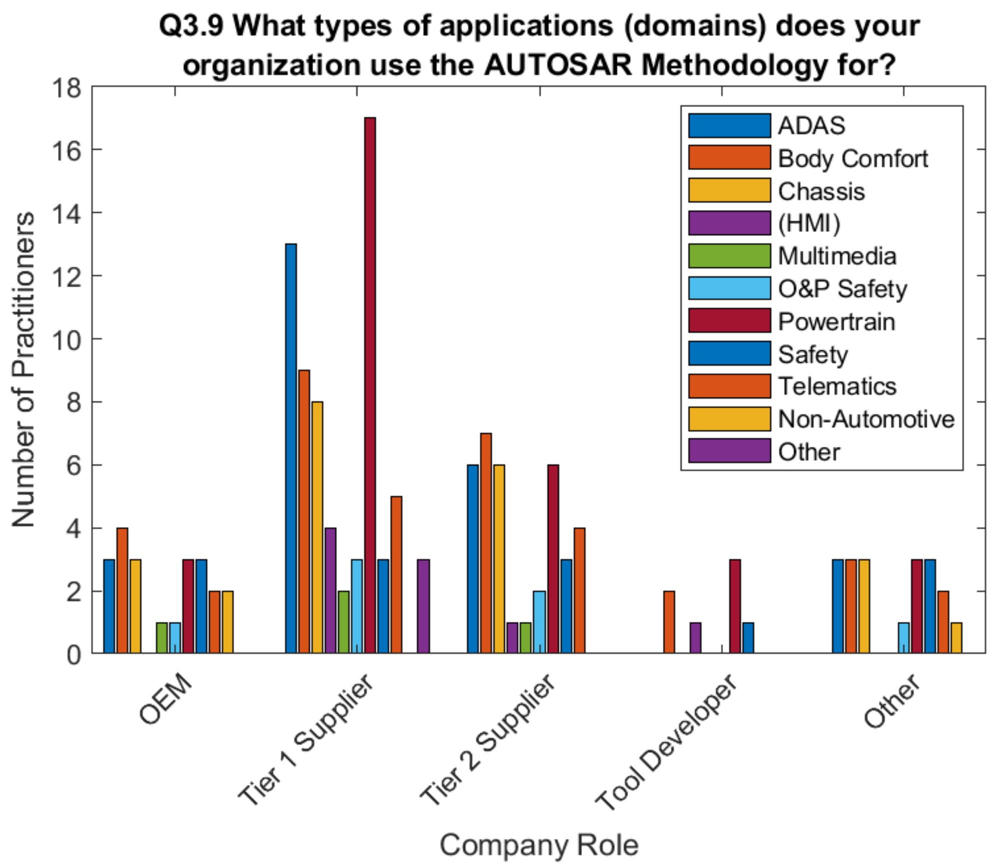



**Figure 26**

*AUTOSAR Application Types by Company Role*

## Q3.10 AUTOSAR Motivation

The purpose of this question was to understand the motivations of practitioners that use AUTOSAR. Options provided were 'Functional safety goals,' 'Reduce reliance on custom architecture,' 'Reuse components across programs and platforms,' 'OEM/Customer requirements,' and 'Other.' Users were free to select any option desired. User-provided comments for ‘Other’ were:

- "usage of of the shelf commercial tools for SW development, avoidance of customer specific solutions"
- “we provide Autosar stacks and solutions”

From the 152 total samples, 50 respondents answered for a 33% response rate. The data showed that OEM/Customer requirements were the most prominent reason practitioners use the AUTOSAR methodology, followed by the reuse of components. This finding would indicate that OEMs are the driving force in adopting AUTOSAR. With requirements being the top response was expected; however, it was expected that reuse would score higher. Figure 27 shows the data by company role.

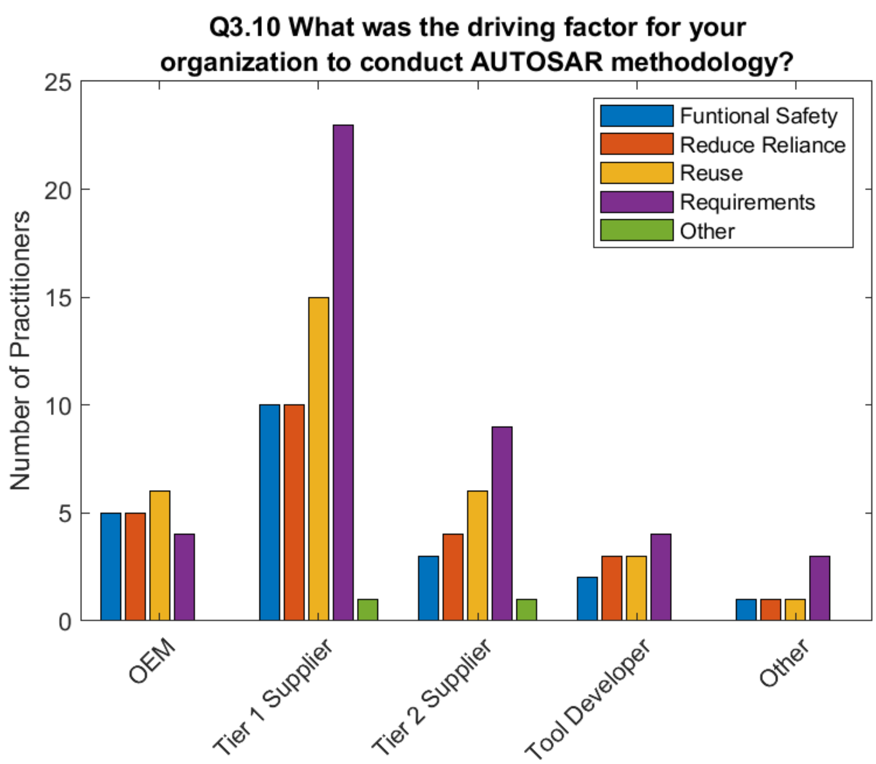



**Figure 27**

*Driving Factors for AUTOSAR*

## Q3.11 AUTOSAR Toolchain

The purpose of this question was to understand what toolchains practitioners use for various tasks in AUTOSAR, which include architecture, diagnostics, calibration data management, hand-code development, model-based development, verification and validation, and other activities.  There were 40 answers given out of the 152 total samples for a 26% response rate.  The responses revealed Vector and MathWorks are the dominant toolchains within AUTOSAR methodology which was expected.  Table 5 summarizes the responses.

**Table 5**

*Respondent Identified AUTOSAR Tools*

| | Archi | Integ | Diag | CDM | HC | MBD | V&V | Other | Total |
|---|---|---|---|---|---|---|---|---|---|
| ASCET | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| Astrée | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| AUTOSAR Builder | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| CANalyzer | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| CANape | 0 | 0 | 0 | 4 | 0 | 0 | 2 | 0 | 6 |
| CANdela | 0 | 0 | 8 | 0 | 0 | 0 | 0 | 0 | 8 |
| CANoe | 0 | 1 | 2 | 0 | 0 | 0 | 3 | 0 | 6 |
| CDM Studio | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 2 |
| Creo | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CRETA | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| Customer Dependent | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| DaVinci | 8 | 9 | 3 | 0 | 0 | 1 | 1 | 0 | 22 |
| Eclipse | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 2 |
| ECU Test | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| Editoren | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 |
| Enterprise Architect | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| Elektrobit | 0 | 2 | 1 | 1 | 1 | 0 | 0 | 1 | 6 |
| Git | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| Gliwa T1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| Hirain | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 6 |
| IBM | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| IDE | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 |
| INCA | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 2 |
| ISOLAR | 2 | 3 | 1 | 0 | 0 | 0 | 0 | 0 | 6 |
| Jenkins | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| Matlab\|Simulink | 0 | 1 | 0 | 0 | 0 | 17 | 2 | 0 | 20 |
| MES Model Examiner | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| MES M-XRAY | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| ODXStudio | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 |
| ORIENTAIS | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 2 |

**Table 6** (continued)

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Parasoft | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| Polyspace | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 3 |
| PreeVision | 2 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 3 |
| Proprietary | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 3 |
| Rhapsody | 3 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 4 |
| Siemens Vsx | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 |
| System Composer | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| TargetLink | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 3 |
| Tasking | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 |
| TESSY | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 2 |
| Text Editor | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 2 |
| Timing Architect | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 2 |
| TPT | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| VectorCAST | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 3 |
| Vector | 1 | 2 | 3 | 1 | 0 | 1 | 4 | 1 | 13 |
| vTest Studio | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 2 |
| Visual Studio | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 |
| VT-System | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |

**Q3.12 Maturity Models**

The purpose of this question was to understand what maturity models AUTOSAR practitioners use. Options provided were 'Automotive SPICE (ISO/IEC 15504)', 'Capability Maturity Model Integration/Capability Maturity Model Integration (CMM/CMMI)', 'Performance Management Maturity Model', 'Test Maturity Model/Test Maturity Model Integration (TMM/TMMI)', and 'Other'. Users were free to select any option desired. As shown in Figure 28, from the 152 total samples, 46 respondents provided an answer for a 30% response rate. The data shows that by far, the maturity model used most by AUTOSAR practitioners is Automotive-SPICE and was what was expected.

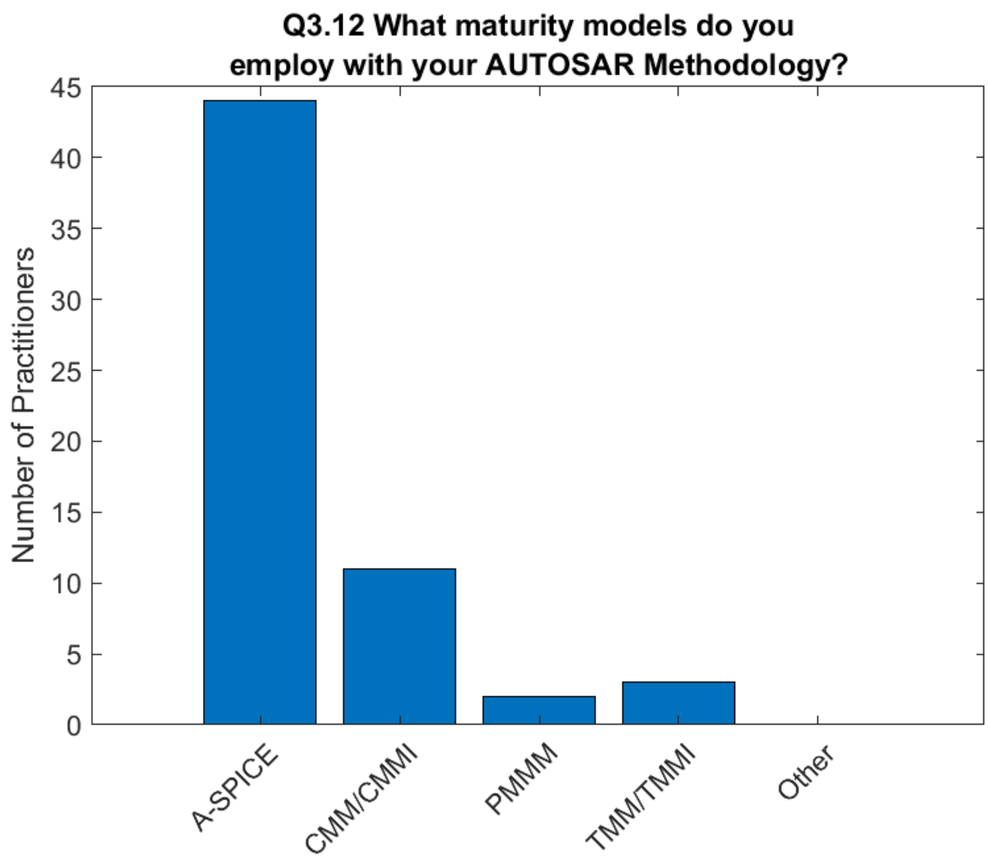



**Figure 28**

*AUTOSAR Maturity Models*

**Q3.13 Functional Safety Standards**

The purpose of this question was to understand what functional safety standards AUTOSAR practitioners follow. Options provided were 'EN 50128 - Railway', 'IEC 60880 - Nuclear', 'IEC 61508 - General', 'IEC 62061 - Manufacturing', 'IEC 62304 - Medical Device', 'ISO 26262 - Automotive', and 'Other'. Users were free to select any option desired. Of the 152 total samples, 47 respondents answered for a 31% response rate. The responses indicate ISO 26262 was by far the most supported functional safety standard and was expected; the data is illustrated in Figure 29.

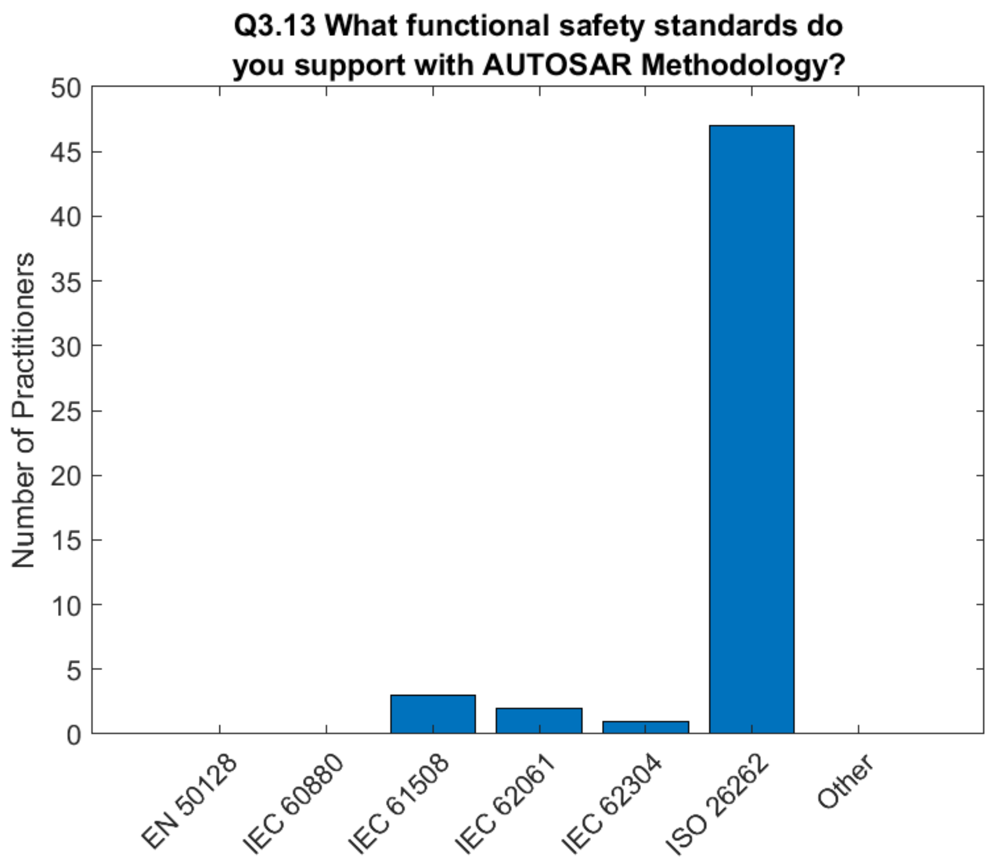



**Figure 29**

*Supported Functional Safety Standards*

### Q3.14 ASIL Levels

The purpose of this question was to understand what ASIL levels AUTOSAR practitioners following ISO 26262 support. This question was only presented to respondents indicating support of ISO 26262 in *Q3.13* . Options provided were 'QM', 'ASIL A', 'ASIL B', 'ASIL C', and 'ASIL D". Users were free to select any option desired. Referring to Figure 30, with the 152 total samples, 46 respondents answered for a 30% response rate. An even mix of ASIL levels supported by the AUTOSAR practitioners was not expected because the expectation was there would have been fewer practitioners supporting the higher ASIL ratings.

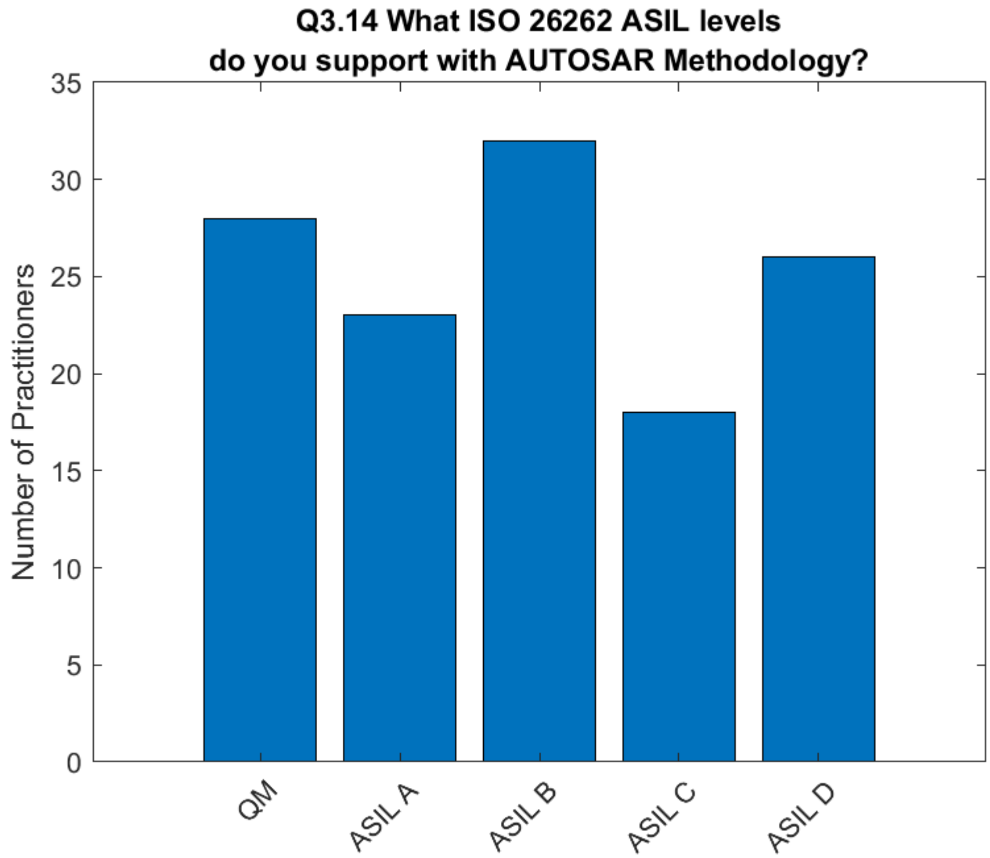



**Figure 30**

*Supported ASIL Levels*

### Q4.1 Education Area

The purpose of this question was to understand the educational background of AUTOSAR practitioners and to compare responses with Martínez-Fernández et al. (2015). Options provided were 'Administration and Management, 'Automotive,' 'Biology,' 'Chemistry,' 'Economy,' 'Electronics,' 'Industrial,' 'Informatics,' 'Mathematics,' 'Physics,' 'Statistics,' 'Telecommunications,' and 'Other.' User-provided comments for 'Other' were:

- "Computer Science"
- "Computer Engineering"
- "computer science"
- "Electrical and Computer Engineering"

With 49 respondents out of the 152 samples answering, for a response rate of 32%, the data shows that AUTOSAR practitioners possessed predominantly automotive and electronics backgrounds, as shown in Figure 31.  The findings were about what was expected for the automotive electronics field.

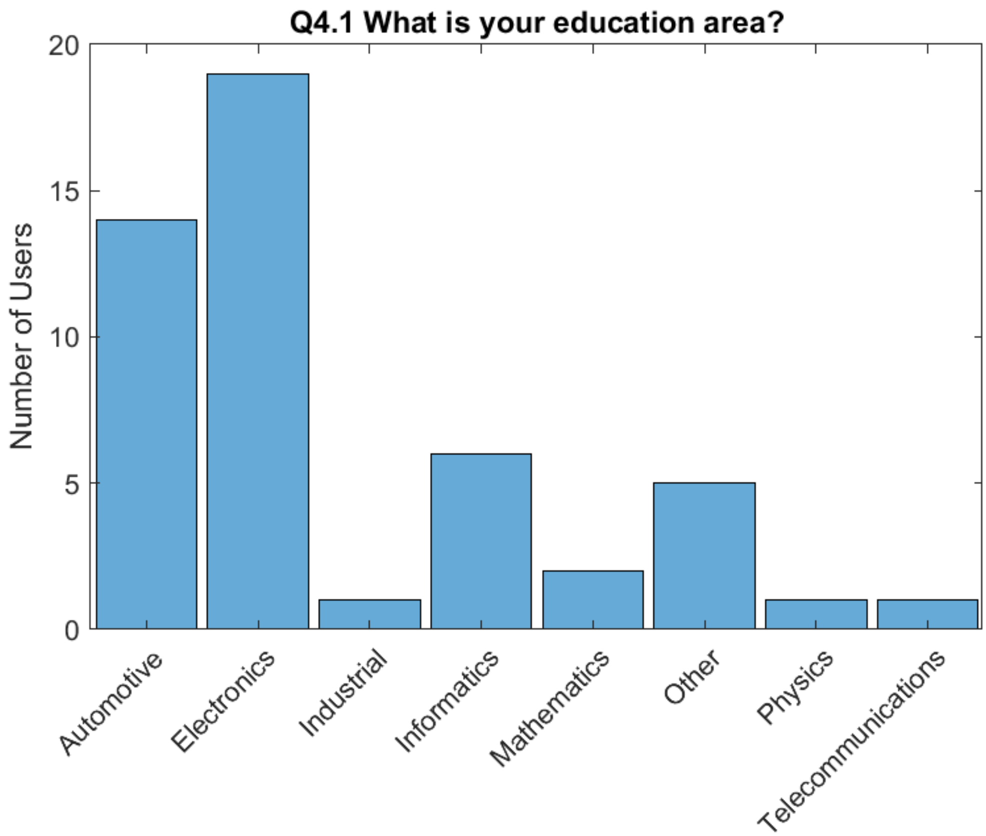



**Figure 31**

*Practitioner Education Area*

### Q4.2 Respondent Country

This question aimed to understand where the practitioners of AUTOSAR, a global standard, are located.  Qualtrics provided a built-in dropdown selection list presented the list of countries for the participant to select.  Of the 152 total samples, 49 respondents provided their country for a response rate of 32%.  As shown in Figure 32, Germany had the highest representation at 15, India had 11, and China had 7.

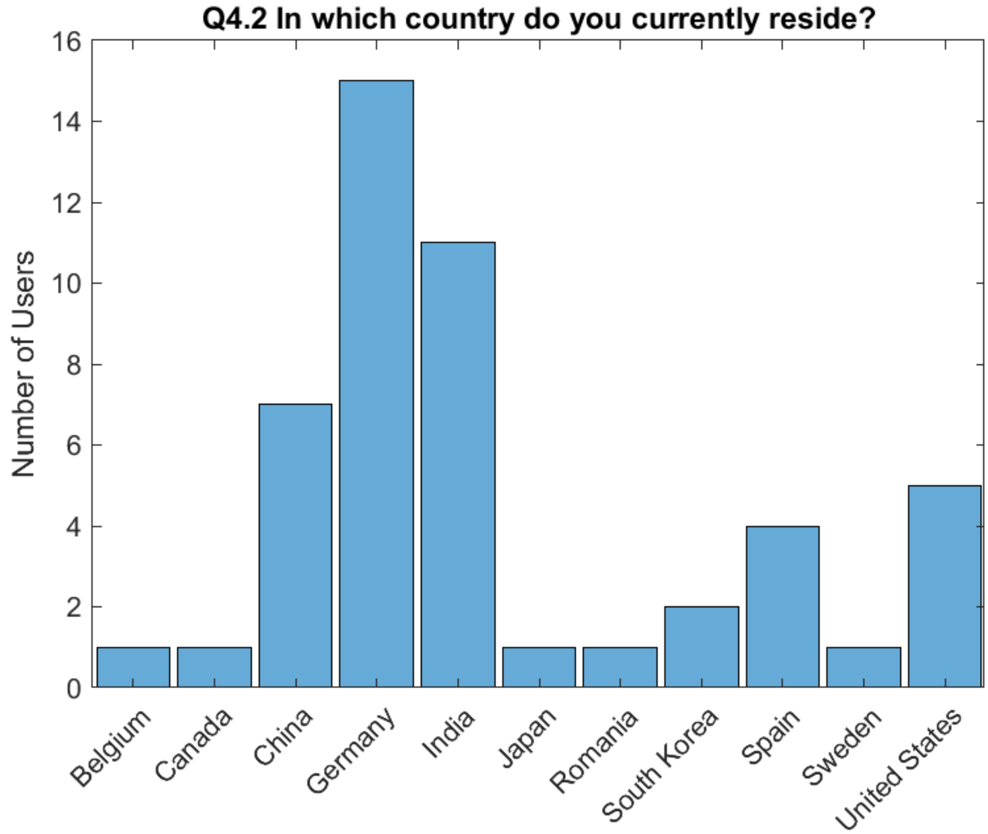



**Figure 32**

*Practitioner Country*

## Q4.3 Respondent Projects

The purpose of this question was to understand the types of project experience of AUTOSAR practitioners. The question consisted of a single comment field. Of the 152 total samples, 31 respondents provided an answer, a response rate of 20 percent. The word cloud in Figure 33 shows that control systems were the predominant theme in AUTOSAR practitioners' experiences.

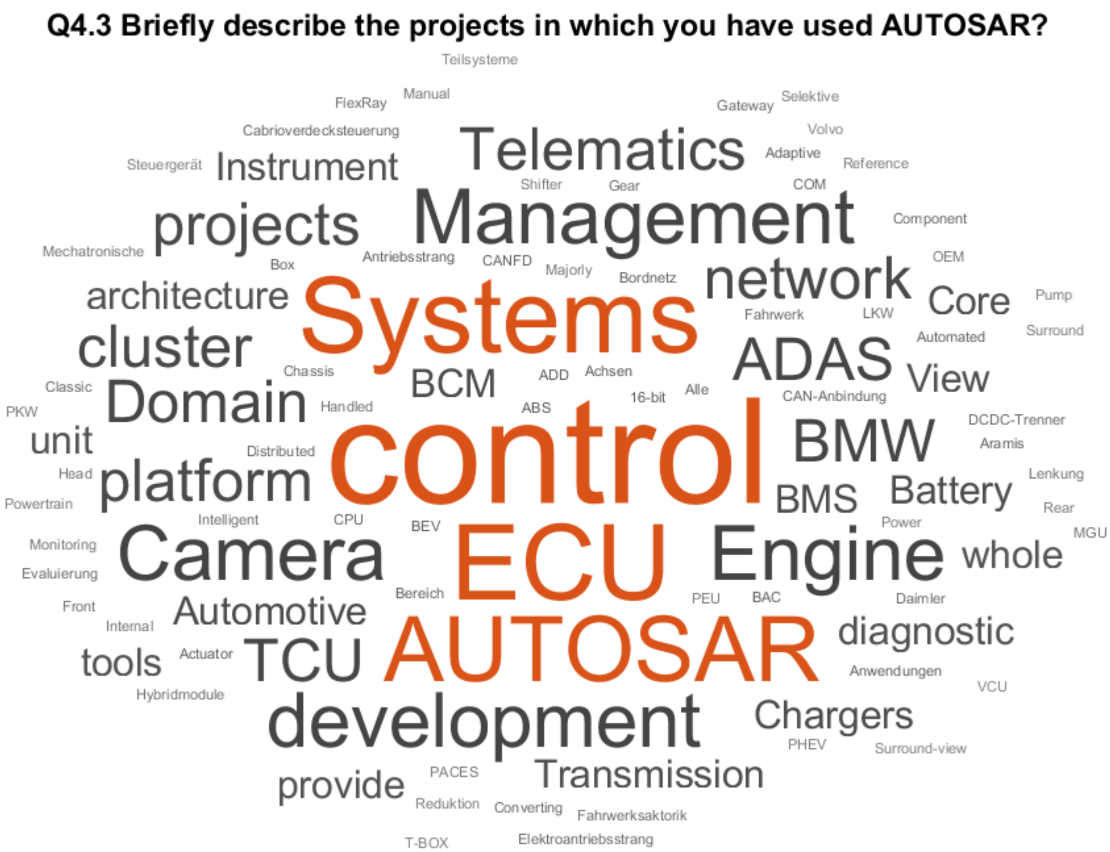



**Figure 33**

*AUTOSAR Practitioner Experiences*

### Q4.4 Respondent Roles

The purpose of this question was to understand the roles of AUTOSAR practitioners. The question consisted of a single comment field. From the 152 total samples, 37 respondents provided their roles which was a 24% response rate. The word cloud in Figure 34 shows Developer, Architect, and Integrator were the predominant themes in AUTOSAR practitioners' roles.


**Figure 34**

*Practitioner Roles*

**Q4.5 Respondent Experience**

The purpose of this question was to understand how long AUTOSAR practitioners have been employing AUTOSAR Methodology. Within the 152 total samples, 46 respondents provided their years of AUTOSAR experience for a 30% response rate. The maximum was 21 years, the minimum was one year, the mean number of years was 7.5, the median was 6.5 years, the range was 20 years, and the standard deviation was 4.7 years. Figure 35 shows boxplots for the practitioner's experience by company role, while Figure 36 does so by application type. As was seen with companies, practitioners indicate half as much experience as AUTOSAR has been a standard. The finding that most practitioners have been practicing AUTOSAR for only about half as long as the AUTOSAR standard has been around was surprising.

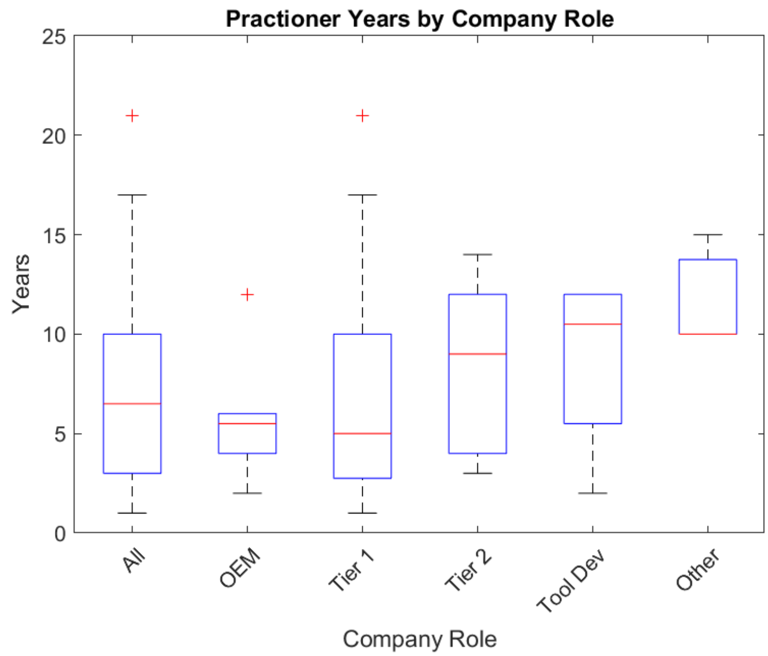



**Figure 35**

*Practitioner Years of Experience by Company Role*

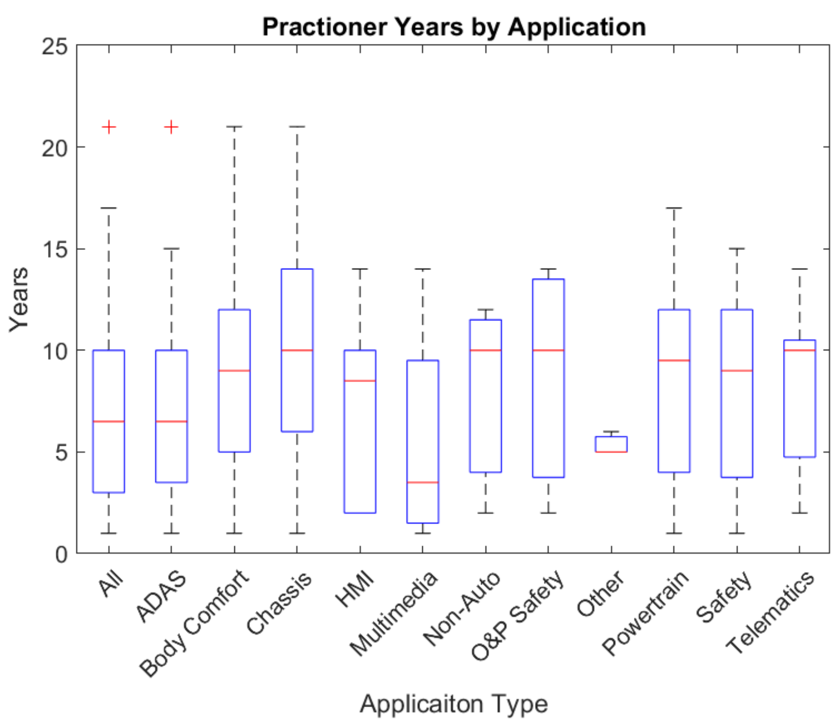



**Figure 36**

*Practitioner Years of Experience by Application Type*

**Q4.6 Open Comments**

The purpose of this question was to ask an open-ended question to elicit non-scripted feedback from the respondents. Of the 152 samples, just 17 respondents for a disappointing 11% response rate. These respondents shared any final thoughts, which are provided in Table 6.

**Table 7**

*Practitioner's Final Thoughts*

| Final Comments |
| --- |
| The methodology is more abstract, and the suggestions are more easy to understand. |
| AUTOSAR has strength on methodology but its standardization speed is somewhat slower recently compared with IT industries. |
| It needs more practice to accumulate experience. Currently, it mainly focuses on BSW |
| Recent days finding it dificult to followup on spec deferences and new adoptations. Need to improve documention on non-autosar to autosar migrations. New concepts should have one document released may be aprt from cocept document. |
| Important in the future: methodologies, techniques for simple ECU-software integration for complex, highly integrated ECUs, and functionally (not component-wise) driven development. |
| AUTOSAR Methodology needs to shift focus to continuous Engineering and usability. Reducing Engineering feedback-loop times where the solution is created in incremental and iterative progress and re-work is minimized is more important than having a comprehensive process. |
| I think it is a good methodology which allows the technical coordination of large teams. |
| number of components and Compositions has a huge variety and depends on type of project and customer |
| most AUTOSAR Tools do not support the full potential of AUTOSAR with all its forma descriptions, many tools are not ergonomic if the project size becomes very large |
| Autosar methodology with Top down approach is the recommended way but practically its not possible. There is always some change down the flow so top need to be updated. Need some hybrid and faster way that defines faster software development process. |

**Table 6** (continued)

AUTOSAR is not a methodology. It is a standard and a layered architecture and implementation framework. We are trying to fit into the AUTOSAR world and have found many features/capabilities lacking in the services offered. The cost of tools, BSW , etc. are very expensive and have steep learning curve. All the tools are not well integrated, e.g. PREEvision, Simulink, CANdela, etc and the workflow is not seamless.

It's fundamentally sound, but requires architects and management to have some background in software engineering or computer science. Without that, the intermediate concepts take a long time and the subtle concepts may not be possible to understand.

Consistent implementation of the methodology requires extremely complex tool landscapes and poor tool interoperability and poor tool performance is one of the biggest problems which, in my opinion, severely restrict the projects.

Furthermore, especially with regard to ECU integration, the collaborative use case in large-scale projects was not really taken into account and, especially in classic AUTOSAR projects, different integration steps can only be parallelized with difficulty and very experienced and broad-based integrators are usually necessary.

Adaptive autosar is being employed recently in the organization which provides a plethora of plug in functionalities.

It should be simplified.

# CHAPTER 5: CONCLUSION

This study answered three questions about how practitioners conduct the AUTOSAR Methodology. These questions included what helped or hindered practitioners and some of the best practices for practitioners of AUTOSAR Methodology. An Internet-based survey of an estimated population of at least 7,000 AUTOSAR practitioners provided answers to these questions. The AUTOSAR standards organization supported the survey and advertised it by email to the AUTOSAR partners and posts in LinkedIn from AUTOSAR and this researcher. The study met with the same problem that other studies have encountered when using convenience sampling surveys within the software engineering domain, obtaining just 152 responses out of the estimated 7,000 AUTOSAR practitioners. Nonetheless, the responses provide exciting information and suggest opportunities for AUTOSAR, its partners, and practitioners to improve and highlight areas for further research.

## Threats to Validity

There were low response rates for the survey overall and more so for each question. This means that even though many findings aligned with expectations, the data cannot be said to be representative of the over 7,000 global AUTOSAR practitioners. The difficulties associated with obtaining representative samples for software engineering-related surveys were identified by de Mello & Travossos et al. (2016) and Martínez-Fernández et al. (2015). The methodology for this study incorporated the AUTOSAR organization to assist with recruiting AUTOSAR practitioners to participate. While this did help obtain more responses overall than that seen by Martínez-Fernández, this study likewise failed to obtain a representative sample. Though the responses statistically cannot be generalized to the entire AUTOSAR practitioner population, the findings are informative and can help drive improvements and topics for further study.

## Who is Practicing AUTOSAR

This research aimed to conduct a global comparison of AUTOSAR methodology. The demographic survey questions Q1.1 and Q4.2 asked respondents what country their companies and themselves were located. The respondents who shared their company and individual countries show that the survey covered AUTOSAR practitioners and companies in 18 countries across four continents. Figure 37 shows a geographical scatter plot of the responses showing a European concentration of practitioners followed by Asia and North and South America. The responses also indicate the survey reached all of the AUTOSAR roles of OEMs, Tier 1 Suppliers, Tier 2 Suppliers, and Tools Developers. Companies averaged 9.5 years of experience with AUTOSAR, while Practitioners had 6.5 years of experience. This finding suggests that either the use of AUTOSAR has substantially grown only within the last ten years or possibly has seen experienced partners leave the organization. Martínez-Fernández et al. (2015) was used extensively as a basis for the design of this study. In comparing results, Martínez-Fernández et al. (2015) reported a smaller percentage of suppliers and a higher percentage of OEMs. Likewise, the reported years of experience for the companies do not agree even when considering the passage of time. Practitioners' education backgrounds Show an increase in those with electronics degrees from Martínez-Fernández et al., likely due to the automotive industry moving towards hybrid and electrical powertrains.

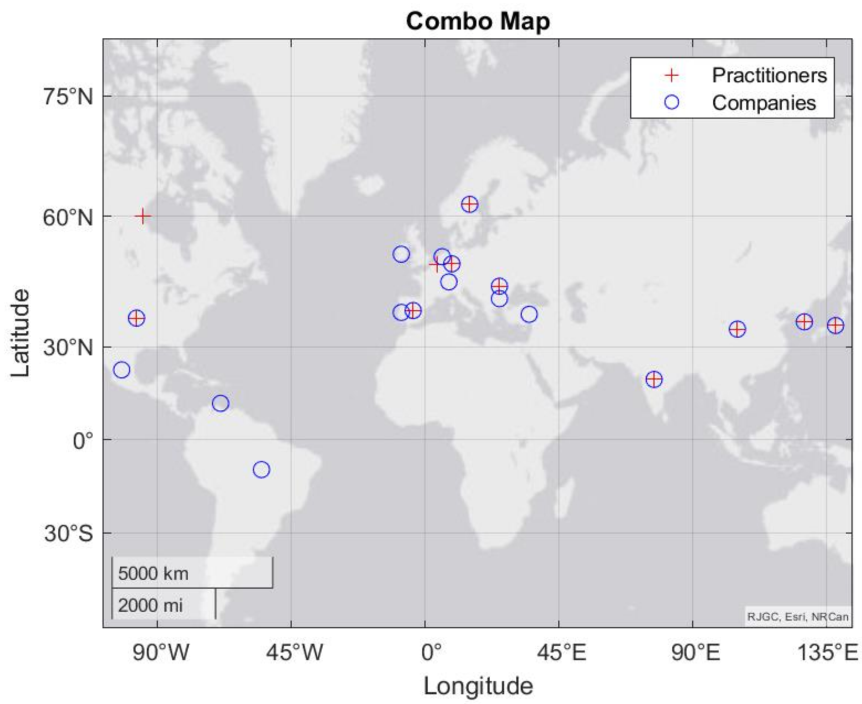
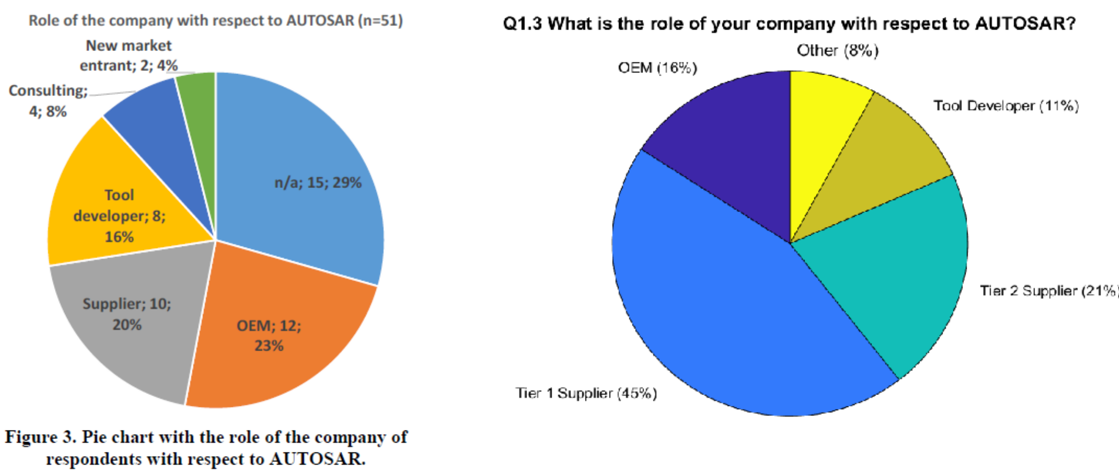



**Figure 37**

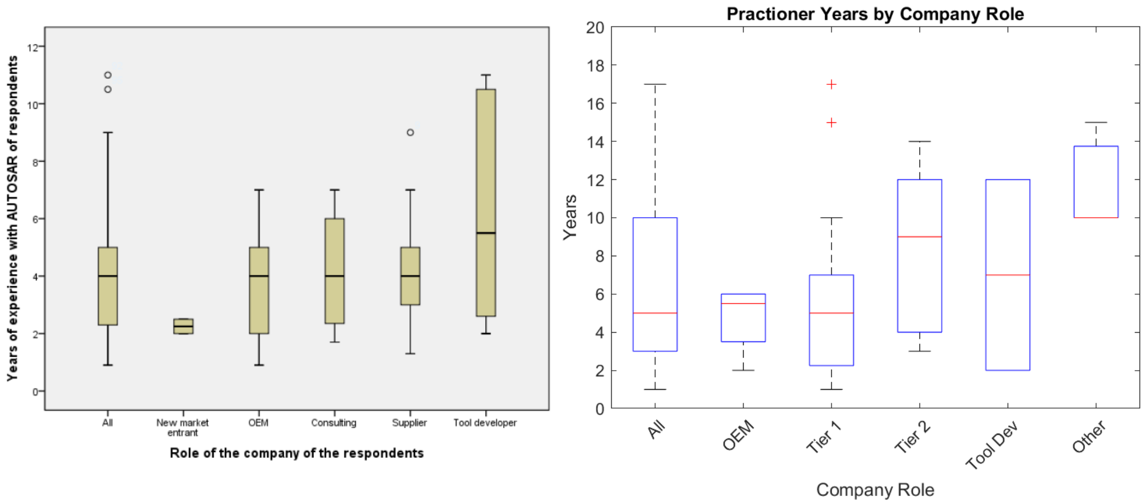
*World Map of AUTOSAR*




Adapted from (Martínez-Fernández, Ayala, Franch, & Nakagawa, 2015)

**Figure 38**

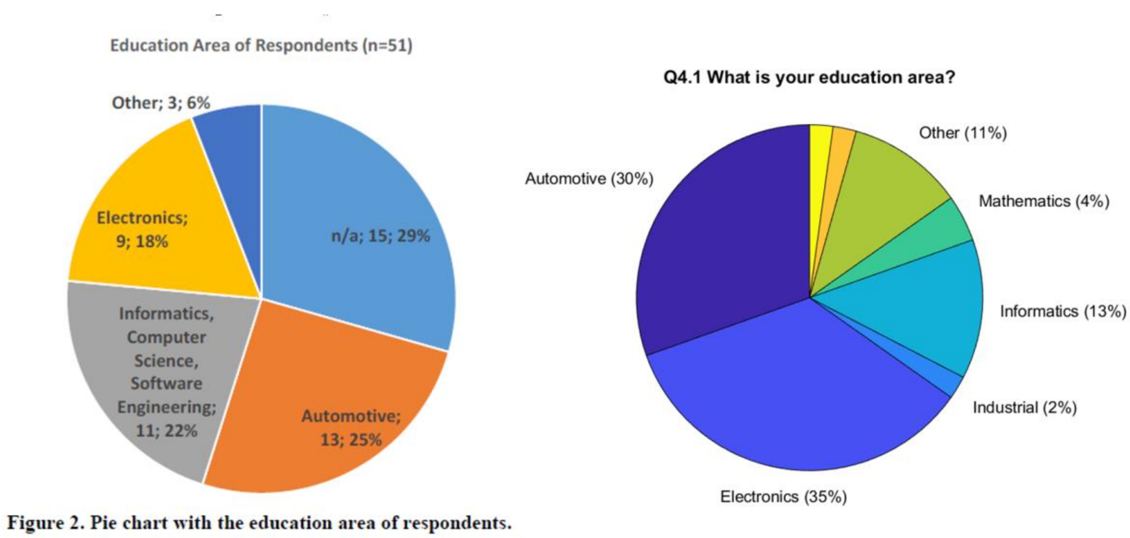
*Comparison to Martínez-Fernández years by company role*




Adapted from (Martínez-Fernández, Ayala, Franch, & Nakagawa, 2015)

**Figure 39**

*Comparison to Martínez-Fernández Practitioner Years by Company Role*




Adapted from (Martínez-Fernández, Ayala, Franch, & Nakagawa, 2015)

**Figure 40**

*Comparison Martinez Practitioner Education Backgrounds*

## Answering RQ1

The first research question asked, "What factors facilitate the application of the AUTOSAR Methodology?" The AUTOSAR practitioners indicated that the AUTOSAR standard is very good at abstracting the hardware/software and application/BSW components. The data indicate that in this regard, AUTOSAR is fulfilling its stated purpose of facilitating the exchange of software amongst AUTOSAR practitioners. The responses also indicate that work product definition and data exchange specifications are not as helpful or are lacking amongst the Tier 1 and Tier 2 suppliers; otherwise, these two choices would have scored just as high as the abstraction choices.

## Answering RQ2

The second research question asked, "What factors impede the application of the AUTOSAR Methodology?" The AUTOSAR practitioners indicated that the AUTOSAR standard is less than ideal for precise modeling. The practitioners also confirmed that the AUTOSAR Methodology impedes its effective utilization by not defining clear roles, timelines, and processes.

## Answering RQ3

The third research question asked, "What are the best practices for developing an AUTOSAR application?" By design, all but two of the survey questions aimed to answer this question. The questions asked how AUTOSAR applications are defined and sized, the deployment of AUTOSAR architects, what workflows and tools practitioners use, and the general experience level and education of those who practice AUTOSAR.

### *AUTOSAR Workflows*

No straightforward best practice was evident. Top-Down and Bottom-Up are practiced nearly equally by the AUTOSAR practitioners. The choice of workflow then should take into consideration the work performed.

### *Make vs. Buy*

The AUTOSAR practitioners were just as likely to externally source AUTOSAR software components as they were to develop components in-house. Therefore, the decision to make or buy will be a business decision rather than a technical one.

### *Generating the system skeleton*

The AUTOSAR practitioners generate the system skeleton almost equally at the contract phase or when the composition or components are defined. Given that the purpose of the system skeleton is to verify architecture, then generating it whenever there are changes is a best practice for identifying issues with architecture early and often in the AUTOSAR software development process.

### *Generating the RTE*

The AUTOSAR practitioners generate the RTE almost equally at the contract phase or when the composition or components are defined. Given that the purpose of the RTE is to provide abstraction between the application and base software, then generating it whenever there are architectural changes is a best practice for identifying issues with architecture early and often in the AUTOSAR software development process.

### *Employing/Deploying Architects*

Most AUTOSAR companies employ 30 or fewer architects distributed amongst various teams, with variation depending on the company’s typical AUTOSAR application. The best practice to ensure architectural control is to minimize the number of architects within the organization with a single architect responsible for an entire project.

### *Application Sizing*

The AUTOSAR practitioners indicate that typical applications contain fewer than 200 software components and fewer than 20 compositions. Keeping the number of components to less than 200 is the best practice for sizing applications.

### *AUTOSAR Applications*

Nearly all AUTOSAR practitioners reported providing automotive-related applications consistent with the original purpose of AUTOSAR being an automotive software architecture. However, the AUTOSAR organization has expressed a desire to expand into other domains and requires more work to enter non-automotive areas.

### *Why Companies do AUTOSAR*

Over half of the responding AUTOSAR practitioners indicate requirements as the motivating factor for implementing requirements. With over 65% of the companies being suppliers, this would indicate that OEMs are the driving force behind the adoption of AUTOSAR and that more the AUTOSAR organization needs to improve messaging and education on the benefits of AUTOSAR.

### *What AUTOSAR tools are in use*

It was clear that tools from Vector and MathWorks are the standard set of tools in use for AUTOSAR application development. Lesser known or unheard of tools, even to AUTOSAR, were identified, indicating a potential future study for tool capability gap analysis.

### *Capability Maturity Models*

That nearly all responses from the AUTOSAR practitioners indicate the use of the Automotive-SPICE capability maturity models is another confirmation of the nearly exclusive use of AUTOSAR for automotive applications, even though the AUTOSAR standard does not prescribe a specific model.

### *Functional Safety Standards*

Another confirmation of the prevalence of automotive applications using AUTOSAR is that most respondents support the automotive functional safety standard ISO 26262. What was surprising was the single response indicating support for the functional safety standard for medical devices, IEC 62304.

# CHAPTER 6: RECOMMENDATIONS

It is important to note again that given the low response rate to the survey and the individual questions, the survey results cannot statistically be considered representative of AUTOSAR practitioners. The responses, however, are still insightful, and from them, several recommendations are made based on the literature review and results of the survey of AUTOSAR practitioners.

## Recommendations for Research

1. As this study replicated the same problems with obtaining representative samples in software engineering surveys, more research is vital to understanding the issue and how future research can effectively improve response rates in such niche domains as automotive software and AUTOSAR.
2. More research is needed to understand better how and why practitioners size AUTOSAR applications the way they do. Why do smaller AUTOSAR applications, such as human-machine interfaces, have proportionally higher components and compositions? Why are there such extreme outliers on the high end of components and compositions in typical applications? Why can most companies create applications with less than 200 components while some need as many as 1,000 components? The first impression of this finding is that the software must be over decomposition or some other form of architecture defect. This finding could also be affected by the finding that some organizations have substantially more architects than others.
3. More research is needed to understand the organizational structure of companies and teams practicing AUTOSAR to answer why some companies have hundreds of architects compared to the typical 50 or less. Again, this finding could explain why some respondents report as many as 1,000 components in an application. Could this be an indication of too many leaders and not enough followers? Conversations with practitioners to ask these questions would be insightful.
4. Research is needed to understand why there is so much tool proliferation in the AUTOSAR space. A gap analysis would be helpful to understand whether there are

problems with interpreting the AUTOSAR standard resulting in other tool vendors attempting to fill the gaps? Could there be a high degree ad hoc extension for the AUTOSAR standard? If so, who is asking for it and why?

5. Last and not least is the issue of authoritative research on the AUTOSAR methodology itself. As was highlighted in the literature review, the theses and dissertations consulted did not study the AUTOSAR methodology, even one that applied Agile to AUTOSAR! The survey responses suggest there continue to be weaknesses in the AUTOSAR methodology as evidenced by responses indicating it was challenging and complex, along with the large number of AUTOSAR tools used by so few respondents. It is apparent there are needs for practicing AUTOSAR, which its methodology is not answering. What will complicate this research is the propensity of companies to treat processes and methods as trade secrets limiting access to the needed data.

**Recommendations for AUTOSAR**

1. The AUTOSAR standard should be updated to provide strong guidance for when each of the basic workflows (Top-Down, Bottom-Up, Round Trip) are appropriate and why. From experience, strict adherence to Top-Down usually means delays in the start of the development while waiting for designs to be fully completed and entered into authoring tools. However, strictly Bottom-Up negatively impacts system-level architectural control.
2. AUTOSAR should look into the issues identified by question 3.11 and have a conversation with the AUTOSAR partners to understand why there is a need for so many tools. The answers to that question could uncover issues with the AUTOSAR standard or its methodology.
3. Given the overwhelming response indicating adherence to Automotive-SPICE, the AUTOSAR standard should add reference process guidance aligned with Automotive-SPICE and the "V" software development model. This reference process should clearly show specific steps with timelines and sequences. Demonstrating in this reference concepts from the methodology such as when to generate ECU extracts, system skeletons, and RTS will enable new AUTOSAR partners and practitioners to

come up to speed sooner. Establishing a reference process would also help tool developers refine and enhance tools through a consistent frame of reference.

4. Many of the sources indicated term confusion and lack of role definitions. While it was highlighted that AUTOSAR had sense added roles to the methodology, their definitions do not align with the software norms for these roles. Architects are concerned with the structure, organization, framework, and constraints. Designers are responsible for implementing and interfacing the entire system. Designers are concerned with translating the architecture into a design plan which developers then implement.
5. The survey reveals that AUTOSAR has not effectively reached outside of the automotive domain. A single respondent indicated their company worked in any other than automotive, manufacturing, and medical. More work is needed to inform and educate the fields AUTOSAR has designated as desirable to enter. An excellent way to do so is by creating a reference application for specially target areas. For example, work with the partner that developed medical devices to develop the reference. Other possibilities include adapting or branching the AUTOSAR standard to appeal to the other domains.
6. A final recommendation for AUTOSAR is, given the identified issues, a formal training and certification program for each of the roles identified in the methodology should be considered. A certified AUTOSAR developer, designer, integrator, tool developer would go a long way towards increasing the perceived standing of and participating in AUTOSAR. Rather than yearly renew exams, an annual continuing education requirement could be used helping to ensure practitioners stay current. Another form of certification to consider is corporate certifications that will give the AUTOSAR partners assurances that everyone is playing by the same rules.

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# APPENDIX A: IRB EXEMPTION

do-not-reply@cayuse.com
Thu 11/4/2021 11:56 AM
To: Padfield, Jon Robert; Stallard, Jason H

PURDUE
UNIVERSITY

This Memo is Generated From the Purdue University Human Research Protection Program System, Cayuse IRB.

**Date:** November 4, 2021
**PI:** Jon Padfield
**Re:** Initial - IRB-2021-996
*Survey of AutoSar users*

The Purdue University Human Research Protection Program (HRPP) has determined that the research project identified above qualifies as exempt from IRB review, under federal human subjects research regulations 45 CFR 46.104. The Category for this Exemption is listed below . Protocols exempted by the Purdue HRPP do not require regular renewal. However, the administrative check-in date is November 4, 2024. The IRB must be notified when this study is closed. If a study closure request has not been initiated by this date, the HRPP will request study status update for the record.

Specific notes related to your study are found below.
**Decision:** Exempt
**Category:**
Category 2.(i). Research that only includes interactions involving educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures, or observation of public behavior (including visual or auditory recording).
The information obtained is recorded by the investigator in such a manner that the identity of the human subjects cannot readily be ascertained, directly or through identifiers linked to the subjects.
Category 2.(ii). Research that only includes interactions involving educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures, or observation of public behavior (including visual or auditory recording).
Any disclosure of the human subjects' responses outside the research would not reasonably place the subjects at risk of criminal or civil liability or be damaging to the subjects' financial standing, employability, educational advancement, or reputation.

**Research Notes:** NA

Any modifications to the approved study must be submitted for review through Cayuse IRB. All approval letters and study documents are located within the Study Details in Cayuse IRB.

What are your responsibilities now, as you move forward with your research?

**Document Retention:** The PI is responsible for keeping all regulated documents, including IRB correspondence such as this letter, approved study documents, and signed consent forms for at least three (3) years following protocol closure for audit purposes. Documents regulated by HIPAA, such as Release Authorizations, must be maintained for six (6) years.

**Site Permission:** If your research is conducted at locations outside of Purdue University (such as schools, hospitals, or businesses), you must obtain written permission from all sites to recruit, consent, study, or observe participants. Generally, such permission comes in the form of a letter from the school superintendent, director, or manager. You must maintain a copy of this permission with study records.

**Training:** All researchers collecting or analyzing data from this study must renew training in human subjects research via the CITI Program (www.citiprogram.org) every 4 years. New personnel must complete training and be added to the protocol before beginning research with human participants or their data.

**Modifications:** Change to any aspect of this protocol or research personnel must be approved by the IRB before implementation, except when necessary to eliminate apparent immediate hazards to subjects or others. In such situations, the IRB should still be notified immediately.

**Unanticipated Problems/Adverse Events:** Unanticipated problems involving risks to subjects or others, serious adverse events, and noncompliance with the approved protocol must be reported to the IRB immediately through an incident report. When in doubt, consult with the HRPP/IRB.

**Monitoring**: The HRPP reminds researchers that this study is subject to monitoring at any time by Purdue's HRPP staff, Institutional Review Board, Post Approval Monitoring team, or authorized external entities. Timely cooperation with monitoring procedures is an expectation of IRB approval.

**Change of Institutions:** If the PI leaves Purdue, the study must be closed or the PI must be replaced on the study or transferred to a new IRB. Studies without a Purdue University PI will be closed.

**Other Approvals:** This Purdue IRB approval covers only regulations related to human subjects research protections (e.g. 45 CFR 46). This determination does not constitute approval from any other Purdue campus departments, research sites, or outside agencies. The Principal Investigator and all researchers are required to affirm that the research meets all applicable local/state/ federal laws and university policies that may apply.

If you have questions about this determination or your responsibilities when conducting human subjects research on this project or any other, please do not hesitate to contact Purdue's HRPP at irb@purdue.edu or 765-494-5942. We are here to help!

Sincerely,

Purdue University Human Research Protection Program/ Institutional Review Board
Login to Cayuse IRB

# APPENDIX B: RECRUITMENT EMAIL

**Jason H Stallard**

| | |
|---|---|
| **From:** | Maria Jurin via Legal Support <legal.support@autosar.org> |
| **Sent:** | Monday, November 22, 2021 5:34 AM |
| **To:** | Jason H Stallard |
| **Cc:** | [S485/20] Mattner Engineers and Advisers Bernd Mattner [IAO] |
| **Subject:** | Re: Recruitment email |

**EXTERNAL SENDER:** This email originated outside of Cummins. Do not click links or open attachments unless you verify the sender and know the content is safe.

Dear Jason,

please find the text below:

*Dear AUTOSAR Experts,*

*We are supporting a survey with the title "Comparison of global implementations of AUTOSAR" on behalf Jon Padfield, PhD, the Principal Investigator for this study (IRB # 2021-996). Dr. Padfield can be reached at jpadfiel@purdue.edu if you have any questions.*

*We are convinced that this overview, which results can be reused even by AUTOSAR, is valuable for the development of the AUTOSAR standard and it will be a great benefit for our partner companies. We intend to publish the results on the AUTOSAR website. If you use AUTOSAR in context of the automotive software development, please take some time and answer the survey. The higher the number of participating practitioners and experts, the more expressive the outcome and the quality of the study will be. It is possible to forward this survey to different divisions within your company to maximize the number of participants.*

*The survey takes approximately 15 minutes of your time. Please find enclosed the questions on qualtrics.*
*https://purdue.ca1.qualtrics.com/jfe/form/SV_08pybMAnC9GvblY*

*The qualitative study will be conducted by utilizing the framework and replicating portions of previous surveys to better understand AUTOSAR methodology.*

*The purpose of the qualitative study is to assess how AUTOSAR development methodology is implemented by OEMs, Tier 1, or Tier 2 suppliers, as well as software and tool vendors. The analysis will look for commonality in the workflows implemented, and more importantly, where and why there is disagreement in the workflows.*

*This analysis of the research can then be used to identify whether any changes are required for the AUTOSAR Methodology as well as to help to document best practices for any entity participating in AUTOSAR development.*

*Because the study is for research purposes and the research findings can be used, an active involvement and participation is highly welcomed. The availability of the research findings is planned for December 2021 and will be shared with AUTOSAR.*

*We are assisting the survey being done by Jason H. Stallard, a doctoral student at Purdue University in West Lafayette, IN, in reaching and obtaining participants.*

*Thank you and best regards*

Best regards

***Maria Jurin***

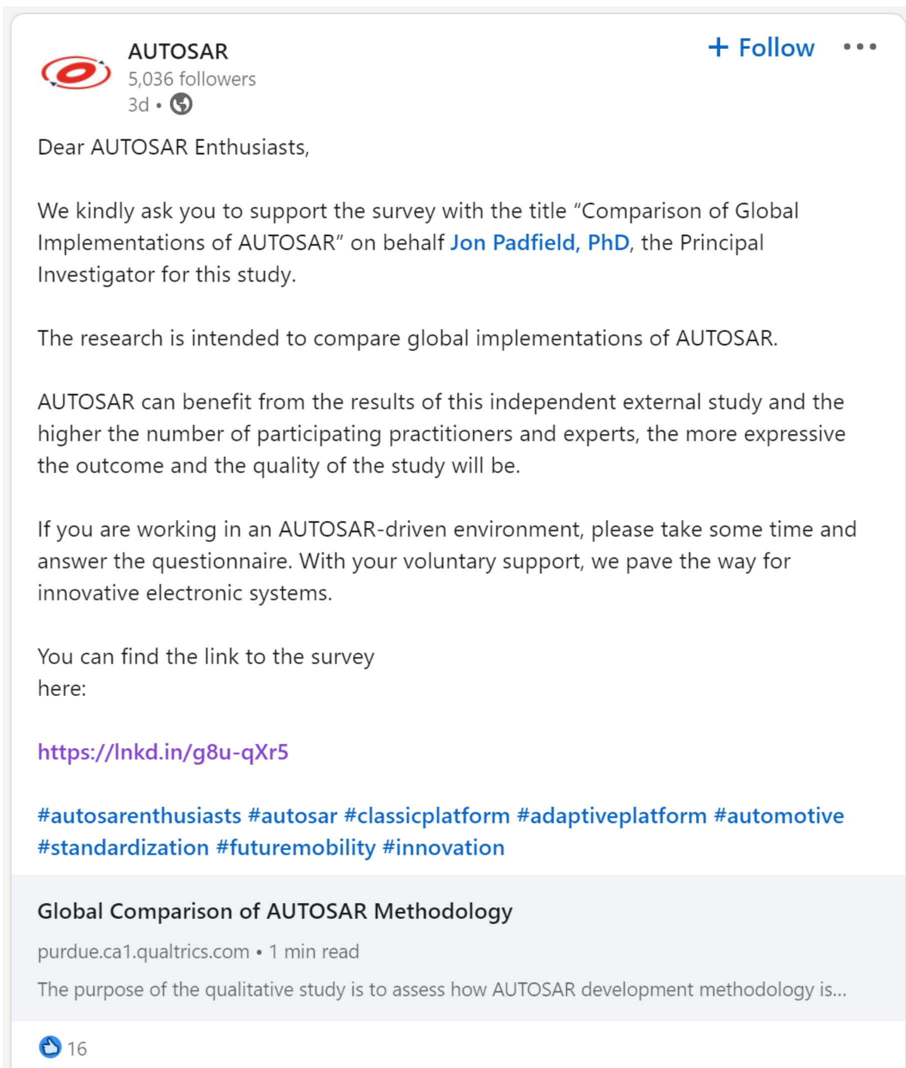
**on behalf of the AUTOSAR Administration**
Please use the answer button on this email to get back to us on this topic.
In case we could answer your question, and you have a new one, please send us a new email and this topic will be closed.

AUTOSAR GbR
Administration
Bremer Straße 11

# APPENDIX C: AUTOSAR LINKEDIN POST

**Figure 41**

*AUTOSAR LinkedIn Post*



AUTOSAR
5,036 followers
3d •

+ Follow

Dear AUTOSAR Enthusiasts,

We kindly ask you to support the survey with the title "Comparison of Global Implementations of AUTOSAR" on behalf Jon Padfield, PhD, the Principal Investigator for this study.

The research is intended to compare global implementations of AUTOSAR.

AUTOSAR can benefit from the results of this independent external study and the higher the number of participating practitioners and experts, the more expressive the outcome and the quality of the study will be.

If you are working in an AUTOSAR-driven environment, please take some time and answer the questionnaire. With your voluntary support, we pave the way for innovative electronic systems.

You can find the link to the survey
here:

https://lnkd.in/g8u-qXr5

#autosarenthusiasts #autosar #classicplatform #adaptiveplatform #automotive #standardization #futuremobility #innovation

Global Comparison of AUTOSAR Methodology
purdue.ca1.qualtrics.com • 1 min read
The purpose of the qualitative study is to assess how AUTOSAR development methodology is...

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# APPENDIX D. LOG OF PERSONAL COMMUNICATIONS

Dr Silverino Martínez-Fernández

- December 22, 2020. At the encouragement of my committee, I contacted Dr Martínez-Fernández through email and we agreed to meet via WebEx from 3:00 to 3:30 PM EST. I spent a couple of minutes informing Dr Martínez-Fernández about my proposal, how I intened to replicated some of his work, and highlighted some of the conserns of my committee regarding anticipated sample size. Dr Martínez-Fernández informed me that his paper came from his Disseration work relating to reference software architectures. He did agree that getting larger survey sample sizes in software engineering is a problam and pointed me to another Disseration and paper treating the issue. I asked Dr Martínez-Fernández how many overall responses he obtained which he said he had 90 altogether. I mentioned that according to the math, I need to get around 350 to get a representative sample, and Dr Martínez-Fernández responded that I would be lucky to get 300 and only if I know where to go and how to get responses. Another feedback I got was to look at the domain classificaitons I'm using (in one my my proposed questions I've asked for what domain the respondent AUTOSAR application classifications are), and to make sure I'm using something that is common/standard. I ased Dr Martínez-Fernández if he would like to help validate my survey and he informed me he would love to collaborate with me.

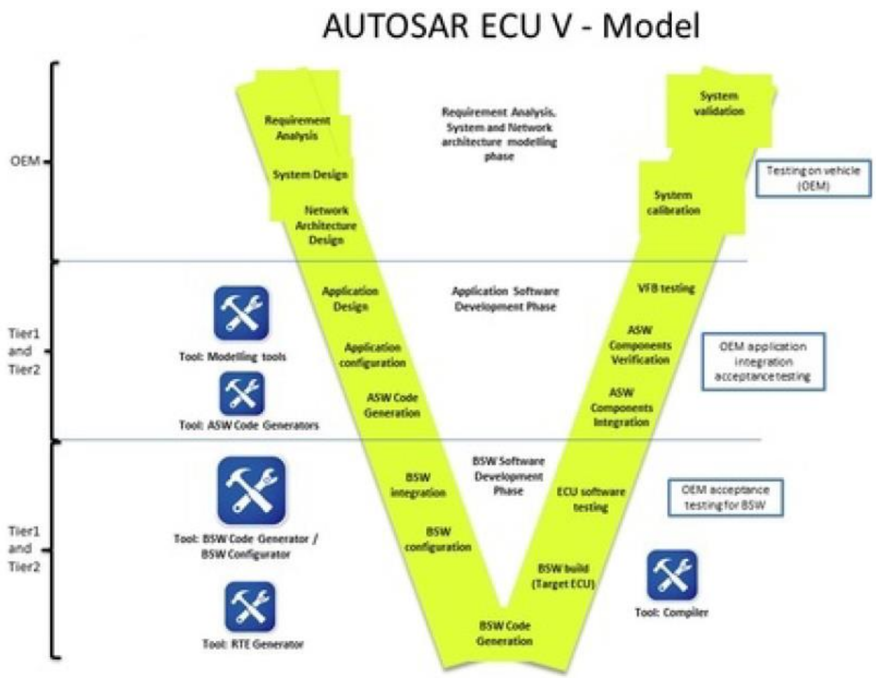
AUTOSAR

- April 12, 2021. I asked the head of the AUTOSAR North American User Group for a contact that I could confer with and I was instructed to reaching out to comms.support@autosar.org. Martin Luntz from Bosch responded to my email and setup a meeting for today along with my colleague, Mousumi Mukhopadhyay, the other Cummins rep to the user group.. I reviewed what my objective for this dissertation and that I was asking for assistance from AUTOSAR in reaching individuals to participate in the study. Mr Luntz was agreeable but needed to confer with AUTOSAR internally for the exact procedure to be used. Martin liked my questions and asked whether AUTOSAR could have input on further developing the survey questions to which I replied, absolutely. He asked if the survey could be done in the name of AUTOSAR to which I said I needed to confer with my Committee. Mr. Luntz also asked whether the results would be made available to the AUTOSAR membership and I responded that I believed that was possible but needed to confer with my Committee first. We both agreed to discuss with our respective committees and will meet again on 9/24/21 at 8 am.

# APPENDIX E: JANARDHAN'S AUTOSAR V-MODEL

**Figure 42**

*An AUTOSAR V-Model*




Source: (Janardhan, 2018, p. 33)

# APPENDIX F: AUTOSAR PARTNERS

**Table 8**

*AUTOSAR Core Partners*

| | | |
|---|---|---|
| BMW Group | Bosch | Continental |
| Daimler | Ford | General Motors |
| PSA Group | Toyota | Volkswagen Group |

Adapted from Core Partners. (n.d.). Retrieved September 20, 2020, from AUTOSAR: https://www.autosar.org/about/current-partners/core-partners/

**Table 9**

*AUTOSAR Strategic Partners*

| | |
|---|---|
| DENSO Corporation | LG Electronics Inc |

Adapted from Strategic Partners. (n.d.). Retrieved September 20, 2020, from AUTOSAR: https://www.autosar.org/about/current-partners/strategic-partners

**Table 10**

*AUTOSAR Premium Partners*

| | | |
|---|---|---|
| Altran | Aptiv | APTJ |
| ARM Limited | Baidu | BlackBerry |
| Capgemini | CEA | Dassault Systemes |
| Deloitte GmbH | dSPACE | Elektrobit |
| eSol | ETAS | Fraunhofer-Gesellschaft |
| Great Wall Motor | Green Hills Software | HCL Technologies Limited |
| Hella | Honda Motor | Huawei Technologies Co., Ltd. |
| Hundai | Infineon Technologies AG | Intel |

**Table 9** (continued)

| | | |
|---|---|---|
| ITK Engineering | Intron Technology | iSOFT |
| JTEKT Corporation | KPIT Technologies Ltd. | Larsen and Tubro Limited |
| LEAR Corporation | Luxoft Holding Inc. | The MathWorks |
| Mentor Graphics Corporation | Mitsubishi Electric Corporation | NEC Corporation |
| NISSAN Motor Company | NXP Semiconductors B.V. | Panasonic Corporation |
| Renault SAS | RENESAS Electronic Corp. | SCSK Corporation |
| Sodius SAS | ST Microelectronics | Sumitomo Electric Industries, Ltd. |
| Tata Elxsi Ltd. | Tata Motors | ThyssenKrupp |
| Valeo SAS | Vector | Veoneer |
| Volvo Truck Corporation | Volvo Car Corporation | Wind River Systems, Inc. |
| ZF Friedrichshafen AG | | |

Adapted from Premium Partners. (n.d.). Retrieved September 20, 2020, from AUTOSAR: https://www.autosar.org/about/current-partners/Premium-partners/

**Table 11**

*AUTOSAR Development Partners*

| | | |
|---|---|---|
| Abup Technology Co.,Ltd | Avelabs LLC. | AVIN Systems Private Limited |
| BASELABS GmbH | BASICWORX ENGINEERING GmbH | b-plus GmbH |
| C2A - Security | Codeplay Software | easycore GmbH |
| eJad Inc. | E.S.R. Labs AG | Evidence Srl |
| Evolution Synergetique Automotive S.L. | Excelfore Corporation | FPT Software |
| Freetech Intelligent Systems Co., Ltd | GAIO TECHNOLOGY CO., LTD. | GLIWA GmbH |
| HANECS GmbH | INCHRON GmbH | IncQuery Labs Ltd. |
| Intrepid Control Systems | IP Camp Kft. | iSYSTEM AG |
| Keysight Technologies \| Ixia | KRONO-SAFE SAS | Lauterbach GmbH |
| MATRICKZ GmbH | Nanjing SemiDrive Technology Limited | NCES, Nagoya University |

**Table 10** (continued)

| | | |
|---|---|---|
| Neusoft Reach Automotive Technology Co., Ltd. | NORDSYS GmbH | OpenSynergy GmbH |
| OSB AG | PLS Programmierbare Logik & Systeme GmbH | PopcornSAR Co.,Ltd. |
| Programming Research Ltd. | Real-Time Innovations (RTI) | RealThingks Automotive Engineering GmbH |
| RTst Co., Ltd. | Saferide Technologies | seneos GmbH |
| Shanghai Hinge Electronic Technology Co., Ltd. | Softing Electronic Science & Technology (Shanghai) Co., Ltd | SYSGO AG |
| TraceTronic GmbH | TTTech Computertechnik AG | Validas AG |
| Vault Micro, Inc. | Verolt Engineering Ltd | Wafer Space Ltd. |

Adapted from Development Partners. (n.d.). Retrieved September 20, 2020, from AUTOSAR: https://www.autosar.org/about/current-partners/development-partners

**Table 12**

*AUTOSAR Associate Partners*

| | | |
|---|---|---|
| ABB Switzerland Ltd | AirPlug Inc. | AISIN |
| AKKA GmbH & Co. KGaA | ALPS ELECTRIC Co., Ltd. | Analog Devices, Inc. |
| Apex.AI | ATEC Co.,Ltd | AVL |
| AXIVION | AZAPA Co., Ltd. | Behr Hella |
| Beijing Jingwei Hirain Technologies | Bertrandt AG | BNSOFT |
| BorgWarner, Inc. | Bose Corporation | BREMBO S.p.A. |
| Brose | Bury GmbH & Co. KG | Cadence Design Systems Inc. |
| Calsonic Kansei Corporation | Caterpillar | CATL Battery |
| CETiTEC GmbH | China FAW Group Corporation | Cisco Systems |
| Clarion Co., Ltd. | CTAG | Cummins Inc. |
| Cypress | Danlaw | Deere & Company |
| Dongfeng | DSA Systems Inc. | eInfochips Ltd. |
| Eiwa System Management, Inc. | EnerSys Delaware Inc. | ESG GmbH |

**Table 11** (continued)

| | | |
|---|---|---|
| FEV GmbH | FIAT CHRYSLER AUTOMOBILES N.V. | Ficosa |
| FUJISOFT Incorporated | Fujitsu Limited | Garmin |
| Gentex Corporation | GKN plc | Glosel Co.,Ltd. |
| GMV Sistemas S.A.U. | GÖPEL electronic GmbH | GRC Automotive Technology (Zhejiang) Co., Ltd. |
| HAGIWARA ELECTRONICS CO., LTD | Helbako | Hitachi Automotive Systems, Ltd. |
| iAuto (Shanghai) Co., Ltd. | iav | Ibeo Automotive Systems GmbH |
| IHI Corperation | iNTENCE automotive GmbH | Irdeto |
| ISUZU Motors Limited | itemis AG | JAC Motors |
| Jasmin Infotech | KALRAY Corporation | Kaspersky Labs GmbH |
| Keihin | KOITO manufacturing Co., Ltd. | ks.MicroNova GmbH |
| KUBOTA Corporation | Leopold KOSTAL GmbH & Co. KG | Magna International Inc. |
| Magneti Marelli S.p.A. | MANDO Corporation | Marquardt GmbH |
| Mazda Motor Corporation | McLaren Automotive Limited | MediaTek Inc. |
| Method Park Holding AG | Microchip | Minda Industries Limited |
| MITSUBISHI MOTORS CORP. | MTA | Murata Manufacturing Co., Ltd. |
| National Instruments | Navistar, Inc. | Nexteer |
| Nidec | NIO GmbH | Nippon Seiki Co., Ltd. |
| NPP Itelma | NSK | NVIDIA |
| Oshkosh Corporation | OTSL, Inc. | Parrot Faurecia Automotive Parrot Faurecia Automotive |
| PCI Solutions, Inc. | PERSOL | PikeTec GmbH |
| PiNTEAM GmbH | Pioneer | PLASTIC OMNIUM sa |
| Preh GmbH | Pure Systems GmbH | ROHM Co.,Ltd. |
| Ryoden Corporation | SAIC Motor | Samsung |
| Schaeffler Technologies AG & Co. KG | SCHEID automotive GmbH | SEG Automotive Germany GmbH |

**Table 11** (continued)

| | | |
|---|---|---|
| Shanghai E-Planet Technologies Co., Ltd. | Shinko Shoji Co., Ltd. | Silexica |
| Silicon Mobility | Stoneridge Electronics AB | Subaru |
| Sunny Gilken Inc. | Suzuki Motor Corporation | Synopsys Inc. |
| Systemite AB | TASKING BV | T.D.I.CO. LTD |
| TDK | Tech Mahindra | Texas Instruments Deutschl. GmbH |
| Tokai Rika Co., Ltd. | Tokai Soft | Toshiba Corporation |
| Toyota Ind. | Toyota Tsusho Corporation | TREMEC |
| TUNG THIH ELECTRONIC CO.,LTD. | Visteon Corporation | Visu-IT! GmbH |
| Weichai Power Co.,Ltd. | Wipro Limited | Witz Corporation |
| Yamaha | Yanfeng Visteon Investment Co., Ltd. | Yazaki Corporation |
| Zhejiang Geely Holding Group Co., Ltd. | ZKW Elektronik GmbH | |

Adapted from Associate Partners. (n.d.). Retrieved September 20, 2020, from AUTOSAR: https://www.autosar.org/about/current-partners/associate-partners

**Table 13**

*AUTOSAR Attendees*

| | | |
|---|---|---|
| Aalen University | ASAM e.V. | Budapest University of Technology and Economics, Department of Measurement and Information Systems |
| Chair for Compiler Construction (CCC) TU Dresden | DGIST | ETRI |
| Friedrich-Alexander-Universität Erlangen-Nürnberg | Hamburg University of Applied Sciences | IFS Institute for Software at HSR Hochschule für Technik Rappperswil |
| Istanbul Okan University | KLE Technological University | Kompetenzzentrum Das virtuelle Fahrzeug Forschungsgesellschaft mbH |
| Ostfalia HAW | OTH Regensburg | Reutlingen University |
| Technische Hochschule Ingolstadt | Technische Hochschule Nürnberg | Technische Universität Braunschweig |

**Table 12** (continued)

| | | |
|---|---|---|
| Technische Universität Clausthal, Institute for Applied Software Systems Engineering (IPSSE) | Technische Universität Darmstadt | Universidad Pública de Navarra |
| Universitat Politècnica de València | Universität Paderborn | Xidian University |

Adapted from Attendees. (n.d.). Retrieved September 20, 2020, from AUTOSAR: https://www.autosar.org/about/current-partners/attendees-partners/

**Table 14**

*AUTOSAR Vendors*

| | | | | | |
|---|---|---|---|---|---|
| 0x0001 | Elektrobit | 0x0030 | See4Sys | 0x005F | KISS Technologies |
| 0x0002 | AEV | 0x0031 | Silicon Mobility | 0x0060 | Nippon Seiki Intern. |
| 0x0003 | Audi | 0x0032 | Patni Comp. Syst. | 0x0061 | Penta Security |
| 0x0004 | Bertrandt | 0x0033 | Johnson Controls | 0x0062 | SCHEID automotive |
| 0x0005 | BMW | 0x0034 | TATA Elxsi | 0x0063 | Akka Germany |
| 0x0006 | Bosch | 0x0035 | Magna | 0x0064 | Elektr. Fahrwerksys. |
| 0x0007 | Carmeq | 0x0036 | Ricardo | 0x0065 | Evidence |
| 0x0008 | Continental | 0x0037 | In2Soft | 0x0066 | SK Pang Electronics |
| 0x0009 | Daimler | 0x0038 | AVL Softw. & Funct. | 0x0067 | in-tech GmbH |
| 0x000A | DeComSys | 0x0039 | BMW/Peug./Citr. El. | 0x0068 | Beijing Jingwei |
| 0x000B | ETAS | 0x003A | Escrypt | 0x0069 | Ford Werke GmbH |
| 0x000C | Fujitsu | 0x003B | Renesas Electronics | 0x006A | Visu-IT! GmbH |
| 0x000D | Hella | 0x003C | ArcCore | 0x006B | ZKW Elektronik |
| 0x000E | IAV | 0x003D | eSOL | 0x006C | crispAudio GmbH |
| 0x000F | IBM | 0x003E | iSOFT Infrastr. Soft. | 0x006D | OMRON Co. Ltd. |
| 0x0010 | MBtech | 0x003F | Toshiba Corporation | 0x006E | GRC Co. Ltd. |

**Table 13** (continued)

| | | | | | |
|---|---|---|---|---|---|
| 0x0011 | Infineon | 0x0040 | Autoliv | 0x006F | BFFT GmbH |
| 0x0012 | Kostal | 0x0041 | NCES: Nagoya Uni. | 0x0070 | TKI Automo. GmbH |
| 0x0013 | Livedevices | 0x0042 | Cypress Semicond. | 0x0071 | BURY |
| 0x0014 | Metrowerks | 0x0043 | Preh | 0x0072 | FUJISOFT Inc. |
| 0x0015 | Mitsubishi | 0x0044 | Wabco | 0x0073 | Samsung Electr. |
| 0x0016 | Motorola | 0x0045 | Behr-Hella Thermo. | 0x0074 | Freetech |
| 0x0017 | NEC | 0x0046 | SCSK | 0x0075 | Semiconductor |
| 0x0018 | Porsche | 0x0047 | E.S.R. Labs | 0x0076 | FPT-Software |
| 0x0019 | Siemens | 0x0048 | AVIN Systems | 0x0077 | Neusoft Reach |
| 0x001A | Softing | 0x0049 | Harman | 0x0078 | FDTech GmbH |
| 0x001B | STMikro | 0x004A | Lear | 0x0079 | b-plus automotive |
| 0x001C | Temic | 0x004B | ITK | 0x007A | LG Electronics Inc. |
| 0x001D | TTTech | 0x004C | Hyundai-Autron | 0x007B | Saic Motor |
| 0x001E | Vector | 0x004D | easycore | 0x007C | Expleo Group |
| 0x001F | Mentor Graphics | 0x004E | APTJ | 0x007D | iNTENCE |
| 0x0020 | VW | 0x004F | Popcornsar | 0x007E | CETiTEC |
| 0x0021 | VW Bordnetze | 0x0050 | Neonode Technol. | 0x007F | Huawei Tech. |
| 0x0022 | WindRiver | 0x0051 | Sunny Giken | 0x0080 | MINDA Industries |
| 0x0023 | dSPACE | 0x0052 | DENSO | 0x0081 | Marquardt GmbH |
| 0x0024 | Delphi | 0x0053 | AUBASS | 0x0082 | FEV Europe GmbH |
| 0x0025 | Micron | 0x0054 | Magneti Marelli | 0x0083 | Krono-Safe |
| 0x0026 | Valeo | 0x0055 | Microchip | 0x0085 | CATL |
| 0x0027 | KPIT | 0x0056 | Hirain Technolog. | 0x0086 | Yanfeng Visteon |

**Table 13** (continued)

| | | | | | |
|---|---|---|---|---|---|
| 0x0028 | Infosys | 0x0057 | ThyssenKrupp | 0x0087 | Weichai Power |
| 0x0029 | Mecel | 0x0058 | Integrated Silicon S. | 0x0088 | Vayavya Labs Pvt. Ltd. |
| 0x002A | Renesas | 0x0059 | e-Traction | 0x0089 | Synopsys, Inc. |
| 0x002B | NXP | 0x005A | AISIN SEIKI | 0x008A | Telechips, Inc. |
| 0x002C | Texas Instruments | 0x005B | Shuanglin | 0x008B | Calterah Semiconductor Technology (Shanghai) Co,.Ltd |
| 0x002D | Volvo Car | 0x005C | iCerti | 0x008C | Nanjing SemiDrive Technology Limited |
| 0x002E | TTAutomotive | 0x005D | iSYS RTS | | |
| 0x002F | ICT | 0x005E | Pektron | | |

Adapted from Vendor ID list. (n.d.). Retrieved September 20, 2020, from AUTOSAR: https://www.autosar.org/about/vendorid/

# APPENDIX G: SURVEY

PURDUE UNIVERSITY

Global Comparison of AUTOSAR Methodology

English

*Survey Intro Block.* The purpose of this survey is to conduct doctoral research in the area of AUTOSAR Methodology and its practice and is done independently at Purdue University.

It is anticipated the time required to complete the survey should be no more than 15 minutes.

Privacy Statement: This Privacy Statement applies to information that can be used to identify you ("Personal Data") and that you provide to Purdue University for the execution of this survey.

The optionally collected demographic data are used for statistical purposes in the study and cannot be linked to you. Therefore, they are not Personal Data in the sense of common data protection regulations.

In addition, our AUTOSAR Methodology Survey collects your voluntary information on specific practices related to the AUTOSAR Methodology and your operational involvement with it. The survey feedback raw data for this research will be destroyed within one year of the completion of the publication of the research results.

Thank you for your time in furthering the body of knowledge related to AUTOSAR Methodology Practices! For any questions or concerns, please contact Jason Stallard via email.

→

PURDUE UNIVERSITY

Global Comparison of AUTOSAR Methodology

English

*Section 1 Intro.* Section 1: Optional Company Demographic Questions

*Q1.1.* What is the name of the country where your company is headquartered?

*Q1.2.* How many years of experience does your company have with AUTOSAR?

*Q1.3.* What is the role of your company with respect to AUTOSAR?

- Original Equipment Manufacturer (OEM)
- Tier 1 Supplier
- Tier 2 Supplier
- Tool Developer
- New Market Entrant
- Other

← →

PURDUE UNIVERSITY

Global Comparison of AUTOSAR Methodology

English

*Section 2 Intro.* Section 2: Required Research Questions

*Q2.1.*
How has AUTOSAR methodology facilitated your application of AUTOSAR?

- ☐ Specifies what information needs to be exchanged between steps
- ☐ Defines work products and contents
- ☐ Separates application development from base software
- ☐ Separates hardware from software
- ☐ None
- ☐ Other/Comments

*Q2.2.* How has AUTOSAR methodology impeded your application of AUTOSAR?

- ☐ Does not define specific processes
- ☐ Does not define roles and responsibilities
- ☐ Does not specify a timeline
- ☐ Interface specifications are not sufficient for precise modeling
- ☐ None
- ☐ Other/Comments

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Global Comparison of AUTOSAR Methodology

English

*Section 3 Intro.* Section 3: Optional Survey Questions

*Q3.1.* Which AUTOSAR workflows do you use?

- ☐ Top-Down
- ☐ Bottom-Up
- ☐ Other

*Q3.2.* For your typical applications, what percentage of your components are supplied vs developed in-house?

- ◯ 0-25%
- ◯ 26-50%
- ◯ 51-75%
- ◯ 76-100%

*Q3.3.* When do you generate the system skeleton?

- ◯ After the architecture is fully defined (contract phase)
- ◯ After the composition interfaces are defined
- ◯ After the component interfaces are defined
- ◯ Other

*Q3.4.* When do you generate the Runtime Environment (RTE)?

- ◯ After the architecture is fully defined (contract phase)
- ◯ After the composition interfaces are defined
- ◯ After the component interfaces are defined
- ◯ Other

*Q3.5.* How many architects does your organization employ?

*Q3.6.* How are architects deployed within your organization?

- ◯ All on the same team
- ◯ Split amongst the system and component teams
- ◯ Other

*Q3.7.* How many components does your typical ECU application contain?

*Q3.8.* How many compositions does your typical ECU application contain?

*Q3.9.* What types of applications (domains) does your organization use the AUTOSAR Methodology for?

- ☐ ADAS
- ☐ Body Comfort
- ☐ Chassis
- ☐ Human Machine Interface (HMI)
- ☐ Multimedia
- ☐ Occupant and Pedestrian Safety
- ☐ Powertrain
- ☐ Safety (ABS, Airbag, etc)
- ☐ Telematics
- ☐ Non-Automotive
- ☐ Other

*Q3.10.* What was the driving factor for your organization to conduct AUTOSAR methodology?

- ☐ Functional safety goals
- ☐ Reduce reliance on custom architecture
- ☐ Reuse of components across programs and platforms
- ☐ OEM/Customer requirements
- ☐ Other

*Q3.11.* Which toolchains do you use for which areas of the methodology?

- ☐ Architecture
- ☐ Diagnostics
- ☐ Integration
- ☐ Calibration data management
- ☐ Hand code development
- ☐ Model based development
- ☐ Validation and verification
- ☐ Other

*Q3.13.* What functional safety standards do you support with AUTOSAR Methodology?

- [ ] EN 50128 - Railway
- [ ] IEC 60880 - Nuclear
- [ ] IEC 61508 - General
- [ ] IEC 62061 - Manufacturing
- [ ] IEC 62304 - Medical Device
- [ ] ISO 26262 - Automotive
- [ ] Other

←  →

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Global Comparison of AUTOSAR Methodology

English

*Section 4 Intro.* Section 4: Optional Personal Demographic Questions

*Q4.1.* What is your education area?

- ○ Administration and Management
- ○ Automotive
- ○ Biology
- ○ Chemistry
- ○ Economy
- ○ Electronics
- ○ Industrial
- ○ Informatics
- ○ Mathematics
- ○ Physics
- ○ Statistics
- ○ Telecommunications
- ○ Other

*Q4.2.* In which country do you currently reside?

*Q4.3.* Briefly describe the projects in which you have used AUTOSAR?

*Q4.4.* What is/was your role/responsibilities in those project(s)?

*Q4.5.* How many years of experience do you have with AUTOSAR?

*Q4.6.* Before finishing the survey, would you like to add any additional comments related to your experience with AUTOSAR Methodology?

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Global Comparison of AUTOSAR Methodology

We thank you for your time spent taking this survey.
Your response has been recorded.

# APPENDIX H. SURVEY DATA

**Table 15**

*Survey Data*

| StartDate | EndDate | Progress | Duration (in seconds) | Finished | RecordedDate | ResponseId | User Language |
|---|---|---|---|---|---|---|---|
| 11/9/2021 14:12 | 11/9/2021 14:31 | 100 | 1158 | TRUE | 11/9/2021 14:31 | R_2eP6KPU57mKJjNl | EN |
| 11/9/2021 18:19 | 11/9/2021 18:30 | 100 | 641 | TRUE | 11/9/2021 18:30 | R_1CBK9kpkj6REZug | ZH-S |
| 11/9/2021 16:54 | 11/9/2021 18:43 | 100 | 6541 | TRUE | 11/9/2021 18:43 | R_3fI4KojILbadskS | EN |
| 11/9/2021 20:01 | 11/9/2021 20:33 | 100 | 1966 | TRUE | 11/9/2021 20:33 | R_xscMvSeJo6qWtuF | EN |
| 11/9/2021 21:45 | 11/9/2021 21:51 | 100 | 363 | TRUE | 11/9/2021 21:51 | R_2roRVCD6WlzI9TW | EN |
| 11/9/2021 20:52 | 11/9/2021 21:51 | 100 | 3594 | TRUE | 11/9/2021 21:51 | R_2pPS9YzKyi1lliM | EN |
| 11/9/2021 23:14 | 11/9/2021 23:22 | 100 | 439 | TRUE | 11/9/2021 23:22 | R_20UnM9RhLEEtTDW | EN |

| StartDate | EndDate | Progress | Duration (in seconds) | Finished | RecordedDate | ResponseId | User Language |
|---|---|---|---|---|---|---|---|
| 11/9/2021 23:17 | 11/9/2021 23:23 | 100 | 397 | TRUE | 11/9/2021 23:23 | R_03oV1N99G9AKvlL | DE |
| 11/10/2021 0:07 | 11/10/2021 0:14 | 100 | 375 | TRUE | 11/10/2021 0:14 | R_3fNR8OKio62urjb | DE |
| 11/10/2021 0:40 | 11/10/2021 1:46 | 100 | 3960 | TRUE | 11/10/2021 1:46 | R_zdsC1DpF02LYYBX | DE |
| 11/10/2021 1:58 | 11/10/2021 2:05 | 100 | 428 | TRUE | 11/10/2021 2:05 | R_3nfm4EUrdQmpRP8 | EN |
| 11/10/2021 2:09 | 11/10/2021 2:17 | 100 | 471 | TRUE | 11/10/2021 2:17 | R_smPZ8LWBRUzUAzT | EN |
| 11/10/2021 2:18 | 11/10/2021 2:25 | 100 | 423 | TRUE | 11/10/2021 2:25 | R_2Qh4hdjpaBe5OMq | EN |
| 11/10/2021 3:20 | 11/10/2021 3:33 | 100 | 791 | TRUE | 11/10/2021 3:33 | R_sbQghV8feckMdoJ | EN |
| 11/10/2021 6:45 | 11/10/2021 7:15 | 100 | 1805 | TRUE | 11/10/2021 7:15 | R_0ozKMIy0zwk54at | EN |
| 11/10/2021 7:57 | 11/10/2021 8:08 | 100 | 660 | TRUE | 11/10/2021 8:08 | R_3Es4sPdhn8ZI1ji | EN |
| 11/10/2021 7:55 | 11/10/2021 8:09 | 100 | 853 | TRUE | 11/10/2021 8:09 | R_2w05vft2RfeOTIs | EN |
| 11/10/2021 2:16 | 11/10/2021 9:01 | 100 | 24285 | TRUE | 11/10/2021 9:01 | R_1mmhaGcWPHA6L9f | DE |

| StartDate | EndDate | Progress | Duration (in seconds) | Finished | RecordedDate | ResponseId | User Language |
|---|---|---|---|---|---|---|---|
| 11/10/2021 8:52 | 11/10/2021 9:03 | 100 | 648 | TRUE | 11/10/2021 9:03 | R_1mwTJu74wYOWvTS | EN |
| 11/10/2021 8:51 | 11/10/2021 9:07 | 100 | 931 | TRUE | 11/10/2021 9:07 | R_2dxTG2Al7zCfZrP | EN |
| 11/10/2021 8:51 | 11/10/2021 9:12 | 100 | 1232 | TRUE | 11/10/2021 9:12 | R_1mQKUlxrAQ381nR | EN |
| 11/10/2021 8:53 | 11/10/2021 9:16 | 100 | 1408 | TRUE | 11/10/2021 9:16 | R_3HBy4EEcaZurqHq | EN |
| 11/10/2021 9:33 | 11/10/2021 9:39 | 100 | 358 | TRUE | 11/10/2021 9:39 | R_2yeI1GGhXSrMF64 | EN |
| 11/9/2021 10:04 | 11/10/2021 10:41 | 100 | 88574 | TRUE | 11/10/2021 10:41 | R_V1Eumkvz1rsmL9n | EN |
| 11/10/2021 12:42 | 11/10/2021 13:03 | 100 | 1306 | TRUE | 11/10/2021 13:03 | R_2VKDqmlVkV9MWi7 | DE |
| 11/10/2021 21:40 | 11/10/2021 21:46 | 100 | 353 | TRUE | 11/10/2021 21:46 | R_3KqMvOaY0b47OJr | EN |
| 11/11/2021 2:48 | 11/11/2021 2:53 | 100 | 283 | TRUE | 11/11/2021 2:53 | R_3JgvpEIqcfmvkVd | EN |
| 11/11/2021 3:10 | 11/11/2021 3:22 | 100 | 678 | TRUE | 11/11/2021 3:22 | R_8oVmTopgRbH68gh | EN |
| 11/11/2021 10:09 | 11/11/2021 10:16 | 100 | 434 | TRUE | 11/11/2021 10:16 | R_3PYq6vljxiwpzcb | EN |

| StartDate | EndDate | Progress | Duration (in seconds) | Finished | RecordedDate | ResponseId | User Language |
|---|---|---|---|---|---|---|---|
| 11/12/2021 7:18 | 11/12/2021 7:26 | 100 | 473 | TRUE | 11/12/2021 7:26 | R_1plYxIbnyxXMmio | EN |
| 11/14/2021 9:09 | 11/14/2021 9:18 | 100 | 544 | TRUE | 11/14/2021 9:18 | R_YRK8PqDckl0rHy1 | DE |
| 11/15/2021 0:35 | 11/15/2021 0:50 | 100 | 911 | TRUE | 11/15/2021 0:50 | R_3oC5nY7VDExnHKy | DE |
| 11/15/2021 12:55 | 11/15/2021 12:59 | 100 | 234 | TRUE | 11/15/2021 12:59 | R_29ivjmWCoT5qZbH | EN |
| 11/9/2021 0:46 | 11/9/2021 0:46 | 3 | 6 | FALSE | 11/16/2021 0:46 | R_3KPnGm8VcBdhssp | DE |
| 11/15/2021 21:17 | 11/16/2021 4:33 | 100 | 26125 | TRUE | 11/16/2021 4:33 | R_239U8thl684fOE8 | EN |
| 11/16/2021 9:01 | 11/16/2021 9:06 | 100 | 267 | TRUE | 11/16/2021 9:06 | R_UbiaQETvbqvXWXD | EN |
| 11/9/2021 13:50 | 11/9/2021 13:52 | 27 | 147 | FALSE | 11/16/2021 13:52 | R_26hzr1HI2jtEDqH | DE |
| 11/9/2021 16:36 | 11/9/2021 16:36 | 3 | 23 | FALSE | 11/16/2021 16:36 | R_erkkdHldcQWXEBj | EN |
| 11/9/2021 16:51 | 11/9/2021 16:55 | 17 | 245 | FALSE | 11/16/2021 16:55 | R_3CBMJsxv1nhDusC | EN |
| 11/9/2021 17:38 | 11/9/2021 17:39 | 3 | 7 | FALSE | 11/16/2021 17:39 | R_2tAnUr5r4Y8NKoy | ZH-S |

| StartDate | EndDate | Progress | Duration (in seconds) | Finished | RecordedDate | ResponseId | User Language |
|---|---|---|---|---|---|---|---|
| 11/9/2021 17:37 | 11/9/2021 17:40 | 3 | 182 | FALSE | 11/16/2021 17:40 | R_1MR5xDy1WhbAISI | JA |
| 11/9/2021 16:40 | 11/9/2021 17:42 | 27 | 3729 | FALSE | 11/16/2021 17:42 | R_VX8CLXBmq1nIzD3 | JA |
| 11/16/2021 19:00 | 11/16/2021 19:04 | 100 | 248 | TRUE | 11/16/2021 19:04 | R_PFcOOpZSzNilbG1 | EN |
| 11/9/2021 19:47 | 11/9/2021 19:53 | 27 | 359 | FALSE | 11/16/2021 19:53 | R_2EGF43PRJcE7yvN | JA |
| 11/9/2021 20:19 | 11/9/2021 20:43 | 27 | 1409 | FALSE | 11/16/2021 20:43 | R_24wxSesETkIxpGq | EN |
| 11/9/2021 22:03 | 11/9/2021 22:03 | 3 | 4 | FALSE | 11/16/2021 22:03 | R_2rvFYFQQ1cG4XRR | EN |
| 11/9/2021 23:55 | 11/9/2021 23:59 | 27 | 222 | FALSE | 11/16/2021 23:59 | R_1n0JSZLR1fGmPWQ | EN |
| 11/10/2021 1:16 | 11/10/2021 1:17 | 17 | 20 | FALSE | 11/17/2021 1:17 | R_3FJ8R4RoisMBvJm | DE |
| 11/17/2021 1:10 | 11/17/2021 1:23 | 100 | 755 | TRUE | 11/17/2021 1:23 | R_3R87BlrsbryY0ZY | EN |
| 11/10/2021 1:30 | 11/10/2021 1:31 | 17 | 81 | FALSE | 11/17/2021 1:31 | R_BPVRjn22bzLCIM1 | ZH-S |
| 11/10/2021 1:31 | 11/10/2021 1:32 | 17 | 52 | FALSE | 11/17/2021 1:32 | R_1jTzSyA5GgNB4Nn | EN |

| StartDate | EndDate | Progress | Duration (in seconds) | Finished | RecordedDate | ResponseId | User Language |
|---|---|---|---|---|---|---|---|
| 11/10/2021 1:42 | 11/10/2021 1:42 | 3 | 4 | FALSE | 11/17/2021 1:42 | R_55YNnJqXlBPFB7z | EN |
| 11/10/2021 1:46 | 11/10/2021 1:46 | 3 | 8 | FALSE | 11/17/2021 1:46 | R_3Oq30U9sLA4rb3J | EN |
| 11/10/2021 1:53 | 11/10/2021 1:54 | 17 | 42 | FALSE | 11/17/2021 1:54 | R_3qWMbvmZqf2W3uJ | EN |
| 11/10/2021 1:59 | 11/10/2021 1:59 | 17 | 27 | FALSE | 11/17/2021 1:59 | R_vZEB2lQRoTavxrr | EN |
| 11/10/2021 2:03 | 11/10/2021 2:03 | 3 | 4 | FALSE | 11/17/2021 2:03 | R_2YzCJgtzS1d1TkS | EN |
| 11/10/2021 2:04 | 11/10/2021 2:04 | 3 | 5 | FALSE | 11/17/2021 2:04 | R_3JIUAZsWpw6XUu1 | EN |
| 11/10/2021 2:07 | 11/10/2021 2:08 | 17 | 21 | FALSE | 11/17/2021 2:08 | R_2bKxX0pe7YwhjUv | EN |
| 11/10/2021 2:04 | 11/10/2021 2:08 | 27 | 212 | FALSE | 11/17/2021 2:08 | R_3KBBGVwg4UJVlQy | EN |
| 11/10/2021 2:08 | 11/10/2021 2:14 | 77 | 374 | FALSE | 11/17/2021 2:14 | R_1rHOm1Py4DYPgPj | EN |
| 11/10/2021 2:17 | 11/10/2021 2:17 | 3 | 7 | FALSE | 11/17/2021 2:17 | R_2ds7yg3sK0SHJdE | EN |
| 11/10/2021 2:17 | 11/10/2021 2:21 | 17 | 198 | FALSE | 11/17/2021 2:21 | R_2atLtqHvjEqwncj | EN |

| StartDate | EndDate | Progress | Duration (in seconds) | Finished | RecordedDate | ResponseId | User Language |
|---|---|---|---|---|---|---|---|
| 11/10/2021 2:51 | 11/10/2021 2:52 | 27 | 63 | FALSE | 11/17/2021 2:52 | R_1gU6dfFpyGFZtQK | EN |
| 11/10/2021 3:03 | 11/10/2021 3:03 | 3 | 11 | FALSE | 11/17/2021 3:03 | R_22n5jpLFZq8YfKP | EN |
| 11/10/2021 3:21 | 11/10/2021 3:21 | 3 | 18 | FALSE | 11/17/2021 3:21 | R_3p5aEtPiWpRnrOX | EN |
| 11/10/2021 3:19 | 11/10/2021 3:22 | 27 | 185 | FALSE | 11/17/2021 3:22 | R_sUcoblpTNAmoXvz | EN |
| 11/10/2021 3:00 | 11/10/2021 3:23 | 3 | 1378 | FALSE | 11/17/2021 3:23 | R_2DRE8G2mIiCUham | EN |
| 11/10/2021 3:23 | 11/10/2021 3:23 | 17 | 29 | FALSE | 11/17/2021 3:23 | R_50BqeVfbGWSDamd | EN |
| 11/10/2021 3:24 | 11/10/2021 3:24 | 3 | 17 | FALSE | 11/17/2021 3:24 | R_BsjSnbNFevYpN6x | EN |
| 11/10/2021 3:27 | 11/10/2021 3:27 | 3 | 23 | FALSE | 11/17/2021 3:27 | R_ufsS1r6AtzPlXS9 | DE |
| 11/10/2021 3:29 | 11/10/2021 3:31 | 3 | 73 | FALSE | 11/17/2021 3:31 | R_33B7S53NUkpYFvn | EN |
| 11/10/2021 3:47 | 11/10/2021 3:54 | 77 | 453 | FALSE | 11/17/2021 3:54 | R_262q3WWHlnMpEEy | EN |
| 11/10/2021 3:57 | 11/10/2021 3:58 | 3 | 18 | FALSE | 11/17/2021 3:58 | R_2DZfiVXnHDtmYzb | EN |

| StartDate | EndDate | Progress | Duration (in seconds) | Finished | RecordedDate | ResponseId | User Language |
|---|---|---|---|---|---|---|---|
| 11/10/2021 4:15 | 11/10/2021 4:16 | 3 | 70 | FALSE | 11/17/2021 4:16 | R_1kHX7lVZAR4XZpe | EN |
| 11/10/2021 4:31 | 11/10/2021 4:32 | 3 | 56 | FALSE | 11/17/2021 4:32 | R_2zqLPFALQL1csTt | EN |
| 11/10/2021 4:41 | 11/10/2021 4:42 | 17 | 51 | FALSE | 11/17/2021 4:42 | R_3IVSneRUxWlJqfs | DE |
| 11/10/2021 4:50 | 11/10/2021 4:52 | 17 | 70 | FALSE | 11/17/2021 4:52 | R_2UadeLflivEUAjk | EN |
| 11/10/2021 4:56 | 11/10/2021 4:57 | 3 | 5 | FALSE | 11/17/2021 4:57 | R_1ODzR0Qrvuvw0Ev | EN |
| 11/10/2021 5:03 | 11/10/2021 5:05 | 27 | 108 | FALSE | 11/17/2021 5:05 | R_XX5D8sVKLyay3Cx | EN |
| 11/10/2021 5:10 | 11/10/2021 5:12 | 77 | 91 | FALSE | 11/17/2021 5:12 | R_2RWliQmptfewad8 | JA |
| 11/10/2021 5:16 | 11/10/2021 5:20 | 17 | 284 | FALSE | 11/17/2021 5:21 | R_3CQ8XJEa2Qj0US2 | EN |
| 11/10/2021 5:39 | 11/10/2021 5:39 | 3 | 8 | FALSE | 11/17/2021 5:39 | R_bswLOW6sme2G9Ed | EN |
| 11/10/2021 5:47 | 11/10/2021 5:47 | 3 | 4 | FALSE | 11/17/2021 5:47 | R_3k5FxPeNYjYxjWM | EN |
| 11/10/2021 7:19 | 11/10/2021 7:19 | 3 | 6 | FALSE | 11/17/2021 7:19 | R_1LBErIo4Af3YyVe | EN |

| StartDate | EndDate | Progress | Duration (in seconds) | Finished | RecordedDate | ResponseId | User Language |
|---|---|---|---|---|---|---|---|
| 11/10/2021 7:50 | 11/10/2021 7:52 | 27 | 123 | FALSE | 11/17/2021 7:52 | R_27egluwldpmvjze | EN |
| 11/10/2021 3:27 | 11/10/2021 8:05 | 3 | 16644 | FALSE | 11/17/2021 8:05 | R_e5NRm9LJEwSeSBP | EN |
| 11/10/2021 8:10 | 11/10/2021 8:10 | 3 | 4 | FALSE | 11/17/2021 8:10 | R_1FFA02oQgqaKH4U | EN |
| 11/10/2021 8:12 | 11/10/2021 8:12 | 3 | 11 | FALSE | 11/17/2021 8:13 | R_3lF77qAtFwZ8yOh | EN |
| 11/10/2021 8:25 | 11/10/2021 8:25 | 3 | 6 | FALSE | 11/17/2021 8:25 | R_1f7pdcirBxuNOd7 | EN |
| 11/10/2021 8:54 | 11/10/2021 8:54 | 3 | 10 | FALSE | 11/17/2021 8:54 | R_3Mgjb7HaGpYuFsM | EN |
| 11/10/2021 8:51 | 11/10/2021 8:56 | 27 | 271 | FALSE | 11/17/2021 8:56 | R_12RO14mLDe0qHQh | EN |
| 11/10/2021 9:00 | 11/10/2021 9:00 | 3 | 11 | FALSE | 11/17/2021 9:00 | R_2D6rUgeh2M5teI8 | EN |
| 11/10/2021 9:30 | 11/10/2021 9:31 | 3 | 14 | FALSE | 11/17/2021 9:31 | R_2uZCKt3Sn7dJufM | EN |
| 11/10/2021 9:40 | 11/10/2021 9:40 | 3 | 5 | FALSE | 11/17/2021 9:40 | R_1fdrNgoAOyGbAm5 | EN |
| 11/10/2021 9:41 | 11/10/2021 9:43 | 17 | 68 | FALSE | 11/17/2021 9:43 | R_1DSvlcIBH3HIDmn | EN |

| StartDate | EndDate | Progress | Duration (in seconds) | Finished | RecordedDate | ResponseId | User Language |
|---|---|---|---|---|---|---|---|
| 11/10/2021 10:27 | 11/10/2021 10:27 | 3 | 5 | FALSE | 11/17/2021 10:27 | R_3k0AlNOM6Nxjgu4 | EN |
| 11/10/2021 10:56 | 11/10/2021 10:56 | 3 | 20 | FALSE | 11/17/2021 10:56 | R_3CN7lki7eO8ThsL | EN |
| 11/10/2021 11:19 | 11/10/2021 11:21 | 27 | 101 | FALSE | 11/17/2021 11:21 | R_UuXUvRDQRIfRWDf | EN |
| 11/10/2021 12:11 | 11/10/2021 12:12 | 3 | 62 | FALSE | 11/17/2021 12:12 | R_6X4ZNPXQmJ3XC2B | EN |
| 11/10/2021 12:38 | 11/10/2021 12:39 | 17 | 60 | FALSE | 11/17/2021 12:39 | R_1HW6T7vDqU6HEMF | EN |
| 11/10/2021 15:04 | 11/10/2021 15:05 | 27 | 51 | FALSE | 11/17/2021 15:05 | R_3g0EcL4lO2hjqFR | DE |
| 11/10/2021 16:10 | 11/10/2021 16:10 | 3 | 22 | FALSE | 11/17/2021 16:10 | R_1LIKUYHSZDDIN7U | EN |
| 11/10/2021 18:21 | 11/10/2021 18:22 | 3 | 18 | FALSE | 11/17/2021 18:22 | R_1OK7dKStpQ2JWpn | EN |
| 11/10/2021 20:04 | 11/10/2021 20:04 | 3 | 8 | FALSE | 11/17/2021 20:04 | R_0TyhhBYbjZbiCJP | EN |
| 11/10/2021 20:06 | 11/10/2021 22:02 | 17 | 6961 | FALSE | 11/17/2021 22:03 | R_2B51EcBx9a6tDEJ | ZH-S |
| 11/10/2021 22:39 | 11/10/2021 22:40 | 3 | 10 | FALSE | 11/17/2021 22:40 | R_51MmtvEyf8v6pHz | EN |

| StartDate | EndDate | Progress | Duration (in seconds) | Finished | RecordedDate | ResponseId | User Language |
|---|---|---|---|---|---|---|---|
| 11/10/2021 23:02 | 11/10/2021 23:04 | 27 | 121 | FALSE | 11/17/2021 23:04 | R_1PcmpftJN7kFsIS | EN |
| 11/10/2021 23:21 | 11/10/2021 23:22 | 17 | 50 | FALSE | 11/17/2021 23:22 | R_2SlxSlCvGCqsLvX | EN |
| 11/10/2021 23:36 | 11/10/2021 23:48 | 27 | 679 | FALSE | 11/17/2021 23:48 | R_1PXDuYQJ0Et0koG | EN |
| 11/18/2021 2:37 | 11/18/2021 2:51 | 100 | 845 | TRUE | 11/18/2021 2:51 | R_1cUmF60eUZdoPKW | EN |
| 11/18/2021 3:42 | 11/18/2021 3:51 | 100 | 538 | TRUE | 11/18/2021 3:51 | R_3HpEZiAPP592YkC | EN |
| 11/11/2021 5:19 | 11/11/2021 5:23 | 27 | 203 | FALSE | 11/18/2021 5:23 | R_3Rkb4Lhhv0ipYc1 | DE |
| 11/11/2021 5:28 | 11/11/2021 5:29 | 3 | 10 | FALSE | 11/18/2021 5:29 | R_qXCLMxbEeORS5ix | EN |
| 11/11/2021 6:51 | 11/11/2021 7:01 | 27 | 618 | FALSE | 11/18/2021 7:01 | R_30oD39QGr30PACL | EN |
| 11/11/2021 8:40 | 11/11/2021 8:40 | 3 | 4 | FALSE | 11/18/2021 8:40 | R_32RQY0R7dUeT8Tn | EN |
| 11/11/2021 8:44 | 11/11/2021 8:45 | 17 | 40 | FALSE | 11/18/2021 8:45 | R_2wmZFh3qy2egEbI | EN |
| 11/11/2021 9:04 | 11/11/2021 9:05 | 17 | 104 | FALSE | 11/18/2021 9:05 | R_PUjDzPqPpPASqFH | EN |

| StartDate | EndDate | Progress | Duration (in seconds) | Finished | RecordedDate | ResponseId | User Language |
|---|---|---|---|---|---|---|---|
| 11/11/2021 12:35 | 11/11/2021 12:36 | 17 | 48 | FALSE | 11/18/2021 12:36 | R_1gB0PPbMJiveYdc | EN |
| 11/18/2021 20:49 | 11/18/2021 20:53 | 100 | 242 | TRUE | 11/18/2021 20:53 | R_3qVW8dCE43oVsM9 | EN |
| 11/18/2021 21:24 | 11/18/2021 21:54 | 100 | 1804 | TRUE | 11/18/2021 21:54 | R_tVrrV5kzdb3Jngd | EN |
| 11/11/2021 22:24 | 11/11/2021 22:24 | 3 | 11 | FALSE | 11/18/2021 22:24 | R_2a95nUX5VOjGQ3b | EN |
| 11/18/2021 22:20 | 11/18/2021 22:35 | 100 | 915 | TRUE | 11/18/2021 22:35 | R_1otizfzuvgJAcxB | EN |
| 11/18/2021 21:54 | 11/18/2021 22:46 | 100 | 3130 | TRUE | 11/18/2021 22:46 | R_WrjboJaoUreICQx | EN |
| 11/19/2021 0:05 | 11/19/2021 0:08 | 100 | 219 | TRUE | 11/19/2021 0:08 | R_2P09vcFGVGkGDHo | EN |
| 11/12/2021 0:18 | 11/12/2021 0:18 | 3 | 13 | FALSE | 11/19/2021 0:18 | R_2OSY6q1966lTdfK | EN |
| 11/18/2021 21:09 | 11/19/2021 2:22 | 100 | 18785 | TRUE | 11/19/2021 2:22 | R_2xFNZejtg13CR7E | EN |
| 11/19/2021 6:16 | 11/19/2021 6:25 | 100 | 491 | TRUE | 11/19/2021 6:25 | R_3R1oroKJIHVIYvP | DE |
| 11/12/2021 6:13 | 11/12/2021 7:01 | 27 | 2890 | FALSE | 11/19/2021 7:01 | R_3dM8UQhOvJGQhND | EN |

| StartDate | EndDate | Progress | Duration (in seconds) | Finished | RecordedDate | ResponseId | User Language |
|---|---|---|---|---|---|---|---|
| 11/19/2021 6:18 | 11/19/2021 7:27 | 100 | 4149 | TRUE | 11/19/2021 7:27 | R_1KwByYHTBvDJBnW | DE |
| 11/12/2021 9:44 | 11/12/2021 9:44 | 17 | 35 | FALSE | 11/19/2021 9:44 | R_3PiDoy3WUNcDmG1 | EN |
| 11/12/2021 10:46 | 11/12/2021 10:46 | 3 | 5 | FALSE | 11/19/2021 10:46 | R_a93h36UBbSzpdhT | EN |
| 11/19/2021 14:04 | 11/19/2021 14:09 | 100 | 281 | TRUE | 11/19/2021 14:09 | R_1Bni6KvzqKUyXQZ | DE |
| 11/12/2021 22:55 | 11/12/2021 22:56 | 17 | 43 | FALSE | 11/19/2021 22:56 | R_9RedTNKVQv4y12x | EN |
| 11/13/2021 2:10 | 11/13/2021 2:13 | 77 | 123 | FALSE | 11/20/2021 2:13 | R_2TRGdd31m4xcHWC | EN |
| 11/14/2021 1:58 | 11/14/2021 1:58 | 3 | 9 | FALSE | 11/21/2021 1:58 | R_23f588HXbAGOQpS | EN |

| Q1.1 | Q1.2 | Q1.3 | Q1.3_5_TEXT |
|---|---|---|---|
| Spain | 5 | Tier 1 Supplier | |
| China | 2 | Tier 1 Supplier | |
| South Korea | 5 | Tier 1 Supplier | |
| China | 12 | Other | Tire1ï¼ŒTire2ï¼ŒAUTOSAR software supplierï¼ŒTools supplier |
| India | 13 | Other | Engineering Service Provider |
| India | 14 | Tier 2 Supplier | |
| India | 10 | Tier 1 Supplier | |
| Germany | 12 | Tool Developer | |

| Q1.1 | Q1.2 | Q1.3 | Q1.3_5_TEXT |
| --- | --- | --- | --- |
| Germany | 10 | Tier 1 Supplier | |
| Germany | 5 | Tier 1 Supplier | |
| Spain | 10 | Tier 2 Supplier | |
| United Kingdom of Great Britain and Northern Ireland | 5 | Original Equipment Manufacturer (OEM) | |
| Romania | 10 | Tier 1 Supplier | |
| Ireland | 10 | Tier 1 Supplier | |
| Spain | 10 | Tier 1 Supplier | |
| India | 15 | Tier 2 Supplier | |
| India | 4 | Tier 1 Supplier | |

| Q1.1 | Q1.2 | Q1.3 | Q1.3_5_TEXT |
|---|---|---|---|
| Germany | 17 | Tier 1 Supplier | |
| United States of America | 3 | Tier 1 Supplier | |
| United States of America | 2 | Tier 1 Supplier | |
| United States of America | 2 | Original Equipment Manufacturer (OEM) | |
| United States of America | 3 | Tier 1 Supplier | |
| India | 3 | Tier 2 Supplier | |
| Germany | 10 | Tier 2 Supplier | |

| Q1.1 | Q1.2 | Q1.3 | Q1.3_5_TEXT |
|---|---|---|---|
| Germany | 15 | Original Equipment Manufacturer (OEM) | |
| India | 15 | Tier 2 Supplier | |
| Germany | 10 | Tier 1 Supplier | |
| Sweden | 14 | Tier 2 Supplier | |
| Germany | 10 | Tier 1 Supplier | |
| Mexico | 10 | Tier 1 Supplier | |
| Germany | 20 | Other | Entwicklungsdienstleister |
| China | 4 | Tier 1 Supplier | |

| Q1.1 | Q1.2 | Q1.3 | Q1.3_5_TEXT |
|---|---|---|---|
| United States of America | 2 | Tier 1 Supplier | |
| India | 2 | Original Equipment Manufacturer (OEM) | |
| Germany | 15 | Tool Developer | |
| Germany | 15 | Tool Developer | |
| Japan | 6 | Tier 2 Supplier | |
| Japan | 6 | Other | è»Šè¼‰ã‚½ãƒ•ãƒˆã‚¦ã‚§ã‚¢å•—è¨—é–‹ç™º |
| Japan | 5 | Tier 1 Supplier | |
| | | Original Equipment Manufacturer (OEM) | |
| Japan | 15 | Original Equipment Manufacturer (OEM) | |
| China | | Tier 1 Supplier | |

| Q1.1 | Q1.2 | Q1.3 | Q1.3_5_TEXT |
|---|---|---|---|
| Germany | 5 | Tool Developer | |
| China | | Tier 2 Supplier | |
| | | Tier 1 Supplier | |
| | | Tier 1 Supplier | |
| China | 0 | Tier 2 Supplier | |
| India | 20 | Tier 2 Supplier | |
| India | 10 | Tier 1 Supplier | |
| Bulgaria | 5 | Tier 1 Supplier | |

| Q1.1 | Q1.2 | Q1.3 | Q1.3_5_TEXT |
|---|---|---|---|
| Spain | 10 | Tier 2 Supplier | |
| Germany | 8 | Tier 1 Supplier | |
| India | 15 | Tier 2 Supplier | |
| Brazil | 8 | Original Equipment Manufacturer (OEM) | |
| United States of America | 3 | Original Equipment Manufacturer (OEM) | |

| Q1.1 | Q1.2 | Q1.3 | Q1.3_5_TEXT |
|---|---|---|---|
| India | | | |
| Germany | 18 | Tier 1 Supplier | |
| India | 5 | Tier 2 Supplier | |
| Germany | 20 | Original Equipment Manufacturer (OEM) | |
| Germany | 6 | Tier 2 Supplier | |
| India | 10 | Tool Developer | |
| United States of America | 10 | Tier 2 Supplier | |
| India | 5 | Tool Developer | |

| Q1.1 | Q1.2 | Q1.3 | Q1.3_5_TEXT |
|---|---|---|---|
| India | 15 | Tier 1 Supplier | |
| Germany | 20 | Other | AUTOSAR Lieferant |
| Germany | 19 | Tier 1 Supplier | |
| Spain | 15 | Tier 1 Supplier | |
| Portugal | 2 | Original Equipment Manufacturer (OEM) | |
| China | 13 | Other | software enterprise |
| China | 2 | Original Equipment Manufacturer (OEM) | |
| China | 10 | Tier 1 Supplier | |
| China | 2 | Original Equipment Manufacturer (OEM) | |
| Germany | 20 | Tier 1 Supplier | |

| Q1.1 | Q1.2 | Q1.3 | Q1.3_5_TEXT |
|---|---|---|---|
| China | 12 | Tool Developer | |
| Germany | 10 | Tier 1 Supplier | |
| Switzerland | 10 | Tool Developer | |
| Germany | 21 | Tier 1 Supplier | |
| Germany | 19 | Original Equipment Manufacturer (OEM) | |
| Turkey | 1 | Tier 1 Supplier | |

| Q2.1 | Q2.1_6_TEXT | Q2.2 | Q2.2_6_TEXT |
|---|---|---|---|
| Separates application development from base software,Separates hardware from software | | None | |
| Separates application development from base software,Separates hardware from software | | Does not specify a timeline,Interface specifications are not sufficient for precise modeling | |
| Separates hardware from software | | None | |
| Specifies what information needs to be exchanged between steps,Defines work products and contents,Separates application development from base software,Separates hardware from software | | Does not define specific processes,Does not specify a timeline,Interface specifications are not sufficient for precise modeling | |
| Specifies what information needs to be exchanged between steps,Separates application development from base software,Separates hardware from software | | Does not specify a timeline | |

| Q2.1 | Q2.1_6_TEXT | Q2.2 | Q2.2_6_TEXT |
|---|---|---|---|
| Separates application development from base software | | Does not define specific processes | |
| Separates application development from base software,Separates hardware from software | | Does not define specific processes,Does not define roles and responsibilities,Does not specify a timeline | |
| Defines work products and contents | | None | |
| Specifies what information needs to be exchanged between steps,Defines work products and contents,Separates application development from base software | | Interface specifications are not sufficient for precise modeling | |

| Q2.1 | Q2.1_6_TEXT | Q2.2 | Q2.2_6_TEXT |
|---|---|---|---|
| Specifies what information needs to be exchanged between steps,Defines work products and contents,Separates application development from base software,Other/Comments | Definiert allgemeine/generische Software-Architektur fuer ECUs. | Interface specifications are not sufficient for precise modeling,Other/Comments | Trennung von generischer / reusable Basissoftware von produkt- und projektspezischen Anteilen in der Autosar-Stack Konfiguration nicht ohne zusaetzliche Features (bspw. "Splittable Konfiguration") moeglich. Funktional einfache Aenderungen (z.B. neues CAN-Signal) erfordern multiple Konfigurationsaenderungen an mehreren Modulen, die sich dann nur schwer der funktionalen Aenderung zuordnen lassen (Tracability). |
| Separates application development from base software,Separates hardware from software | | None | |
| Defines work products and contents,Separates application development from base software | | None | |
| Specifies what information needs to be exchanged between steps,Separates application development from base software,Separates hardware from software | | Does not define roles and responsibilities,None | |

| Q2.1 | Q2.1_6_TEXT | Q2.2 | Q2.2_6_TEXT |
|---|---|---|---|
| Specifies what information needs to be exchanged between steps,Defines work products and contents,Separates application development from base software,Separates hardware from software | | Does not define roles and responsibilities,Does not specify a timeline,Other/Comments | Many people consider it "outdated" now<br>It's not easy to explain to outsiders from management or other domains<br>Basic software configuration/integration work is not interesting to Engineers due to time spent struggling with tooling rather than building a solution<br>Bad implementation and tooling vendors like Mentor Graphics (now Siemens) gave it bad reputation of being slow and too complex and a lot manual workload |
| Separates application development from base software | | None | |
| Separates application development from base software,Separates hardware from software | | Interface specifications are not sufficient for precise modeling | |
| Defines work products and contents,Separates application development from base software | | Does not define specific processes,Other/Comments | |

| Q2.1 | Q2.1_6_TEXT | Q2.2 | Q2.2_6_TEXT |
|---|---|---|---|
| Specifies what information needs to be exchanged between steps,Other/Comments | standardized BSW supports combination of BSW products from different vendors methodology defines standardized format for software component, BSW module and ECU configuration descriptions | Interface specifications are not sufficient for precise modeling,Other/Comments | AUTOSAR ARXML format is complex and its very often unclear what kind of configurations are a valid model models in AUTOSAR ARXML becoming huge |
| Specifies what information needs to be exchanged between steps,Separates application development from base software | | None | |
| Defines work products and contents,Separates application development from base software,Separates hardware from software | | Other/Comments | To many unknowns to leave implementers to their own "devices" without a rigid structure. Lots of options lead to confusion on what is the best option. |
| Separates application development from base software | | Does not define roles and responsibilities | |

| Q2.1 | Q2.1_6_TEXT | Q2.2 | Q2.2_6_TEXT |
|---|---|---|---|
| Other/Comments | Some groups have attempted to keep the existing processes, modify them slightly, and relabel them as AUTOSAR. Not all groups, but some. In the big picture, the AUTOSAR levels have been split into different organizations. | Does not define specific processes,Interface specifications are not sufficient for precise modeling | |
| Defines work products and contents,Separates application development from base software,Separates hardware from software | | Does not define roles and responsibilities,Interface specifications are not sufficient for precise modeling | |
| Specifies what information needs to be exchanged between steps,Defines work products and contents,Separates application development from base software | | Interface specifications are not sufficient for precise modeling | |
| Specifies what information needs to be exchanged between steps,Defines work products and contents,Separates hardware from software | | Does not define specific processes,Interface specifications are not sufficient for precise modeling | |

| Q2.1 | Q2.1_6_TEXT | Q2.2 | Q2.2_6_TEXT |
|---|---|---|---|
| Separates application development from base software,Separates hardware from software | | Interface specifications are not sufficient for precise modeling | |
| Specifies what information needs to be exchanged between steps,Separates application development from base software,Separates hardware from software | | None | |
| Specifies what information needs to be exchanged between steps,Defines work products and contents,Separates application development from base software,Separates hardware from software | | Interface specifications are not sufficient for precise modeling | |
| Specifies what information needs to be exchanged between steps,Separates application development from base software,Separates hardware from software | | Does not define roles and responsibilities,Interface specifications are not sufficient for precise modeling | |
| Separates application development from base software | | None | |

| Q2.1 | Q2.1_6_TEXT | Q2.2 | Q2.2_6_TEXT |
|---|---|---|---|
| Specifies what information needs to be exchanged between steps,Separates application development from base software,Separates hardware from software | | None | |
| Other/Comments | Leider noch wenig. Die Idee dass AUTOSAR mehr UnterstÃ¼tzung als zusÃ¤tzliche Belastung sein kann, setzt sich nur langsam durch. Der Widerstand Legacy Code durch AUTOSAR zu ersetzen ist bei den meisten Mitarbeitern hoch. | Does not define specific processes,Does not define roles and responsibilities,Interface specifications are not sufficient for precise modeling,Other/Comments | Hauptgrund ist der allgemeine Widerstand, aber die Punkte oben sind mit ein Grund.<br>Es mÃ¼sste eine ASPICE, ASIL x usw. konforme Prozessvorlage geben, die aber auch die RealitÃ¤t einschlieÃŸt. |
| Specifies what information needs to be exchanged between steps,Separates application development from base software,Separates hardware from software | | Does not define specific processes,Does not define roles and responsibilities,Other/Comments | Application of industry standards, such as SAE J1939, is very limited. |
| Separates hardware from software | | Does not define specific processes | |
| Defines work products and contents,Separates application development from base software | | Does not define specific processes,Does not define roles and responsibilities,Does not specify a timeline | |

| Q2.1 | Q2.1_6_TEXT | Q2.2 | Q2.2_6_TEXT |
|---|---|---|---|
| None | | None | |
| Specifies what information needs to be exchanged between steps,Defines work products and contents,Separates application development from base software,Separates hardware from software | | None | |
| Specifies what information needs to be exchanged between steps,Defines work products and contents,Separates application development from base software | | Does not specify a timeline | |
| Defines work products and contents,Separates application development from base software | | Does not define specific processes | |
| Specifies what information needs to be exchanged between steps,Defines work products and contents,Separates application development from base software,Separates hardware from software | | Does not define specific processes,Interface specifications are not sufficient for precise modeling | |

| Q2.1 | Q2.1_6_TEXT | Q2.2 | Q2.2_6_TEXT |
|---|---|---|---|
| Specifies what information needs to be exchanged between steps | | Interface specifications are not sufficient for precise modeling | |
| Separates application development from base software,Separates hardware from software | | None | |
| None | | Does not define specific processes,Does not define roles and responsibilities,Does not specify a timeline,Interface specifications are not sufficient for precise modeling | |
| Separates application development from base software,Separates hardware from software | | Does not define roles and responsibilities | |

| Q2.1 | Q2.1_6_TEXT | Q2.2 | Q2.2_6_TEXT |
|---|---|---|---|
| Defines work products and contents,Separates hardware from software | | Interface specifications are not sufficient for precise modeling | |
| Separates application development from base software,Separates hardware from software | | None | |
| Defines work products and contents,Separates application development from base software,Separates hardware from software | | None | |

| Q2.1 | Q2.1_6_TEXT | Q2.2 | Q2.2_6_TEXT |
|---|---|---|---|
| Specifies what information needs to be exchanged between steps,Defines work products and contents,Separates application development from base software,Separates hardware from software | | Does not define roles and responsibilities,Does not specify a timeline | |
| Defines work products and contents | | Interface specifications are not sufficient for precise modeling | |
| Separates application development from base software | | Does not define specific processes | |
| Specifies what information needs to be exchanged between steps,Separates application development from base software,Separates hardware from software | | Interface specifications are not sufficient for precise modeling | |

| Q2.1 | Q2.1_6_TEXT | Q2.2 | Q2.2_6_TEXT |
|---|---|---|---|
| Specifies what information needs to be exchanged between steps,Separates application development from base software,Separates hardware from software | | Does not define specific processes,Does not specify a timeline | |
| Specifies what information needs to be exchanged between steps,Defines work products and contents,Separates application development from base software,Separates hardware from software | | Interface specifications are not sufficient for precise modeling | |
| Separates application development from base software | | None | |

| Q2.1 | Q2.1_6_TEXT | Q2.2 | Q2.2_6_TEXT |
|---|---|---|---|
| Defines work products and contents | | Other/Comments | Performance is not good |
| Separates application development from base software | | Interface specifications are not sufficient for precise modeling | |
| Specifies what information needs to be exchanged between steps,Separates application development from base software | | Interface specifications are not sufficient for precise modeling | |
| None | | Other/Comments | AUTOSAR ist zu komplex |
| Defines work products and contents,Separates application development from base software | | Interface specifications are not sufficient for precise modeling,Other/Comments | Specifications are available but structure of documents is not will maintained. Not very sure when which document has to referred |
| Separates hardware from software | | None | |
| Separates application development from base software | | Does not define roles and responsibilities | |

| Q2.1 | Q2.1_6_TEXT | Q2.2 | Q2.2_6_TEXT |
|---|---|---|---|
| Separates application development from base software,Other/Comments | It is really complicated. Most of engineers think current AUTOSAR methodology and toolchain cause more time to develop the software. | Other/Comments | It is more complicated than legacy development. The toolchain is also not friendly to developers. |
| Specifies what information needs to be exchanged between steps,Defines work products and contents,Separates application development from base software,Separates hardware from software | | Does not define roles and responsibilities,Does not specify a timeline | |
| Specifies what information needs to be exchanged between steps,Defines work products and contents,Separates application development from base software,Separates hardware from software | | Does not define roles and responsibilities,Does not specify a timeline,Interface specifications are not sufficient for precise modeling | |
| Defines work products and contents,Separates application development from base software,Separates hardware from software | | Other/Comments | some compatibility problems between tools from different vendors |

| Q2.1 | Q2.1_6_TEXT | Q2.2 | Q2.2_6_TEXT |
|---|---|---|---|
| Specifies what information needs to be exchanged between steps,Defines work products and contents,Separates application development from base software,Separates hardware from software | | Interface specifications are not sufficient for precise modeling,Other/Comments | Arbeit an der Konfiguration durch mehrere Entwickler nur sehr umstÃ¤ndlich mÃ¶glich. |
| Specifies what information needs to be exchanged between steps,Defines work products and contents,Separates application development from base software | | Does not define specific processes,Does not specify a timeline | |
| Specifies what information needs to be exchanged between steps,Defines work products and contents | | Other/Comments | Verteiltes Arbeiten wird schlecht unterstÃ¼tzt. |
| Specifies what information needs to be exchanged between steps,Defines work products and contents,Separates application development from base software,Separates hardware from software | | Does not specify a timeline | |
| Other/Comments | s | Other/Comments | s |

| Q3.1 | Q3.1_3_TEXT | Q3.2 | Q3.3 | Q3.3_4_TEXT |
|---|---|---|---|---|
| Bottom-Up | | 0-25% | After the architecture is fully defined (contract phase) | |
| Top-Down | | 26-50% | After the composition interfaces are defined | |
| Top-Down,Other | Mixed way<br>- Goal is defined by PL & Experts<br>- Experts on detail specifications work | 76-100% | After the composition interfaces are defined | |
| Top-Down,Bottom-Up | | 0-25% | After the component interfaces are defined | |
| Bottom-Up | | 51-75% | After the architecture is fully defined (contract phase) | |
| Top-Down | | 0-25% | After the component interfaces are defined | |
| Top-Down | | 76-100% | After the composition interfaces are defined | |
| Top-Down,Bottom-Up | | 76-100% | Other | n.a. |

| Q3.1 | Q3.1_3_TEXT | Q3.2 | Q3.3 | Q3.3_4_TEXT |
|---|---|---|---|---|
| Top-Down,Bottom-Up | | 51-75% | After the architecture is fully defined (contract phase) | |
| | | 0-25% | Other | Weil meist System_neu_entwicklungen, entsteht i.L.d. Entwicklung iterativ. |
| Top-Down,Bottom-Up | | 0-25% | After the component interfaces are defined | |
| Top-Down,Bottom-Up | | 0-25% | After the composition interfaces are defined | |
| Top-Down | | 26-50% | After the composition interfaces are defined | |
| Top-Down,Bottom-Up | | 0-25% | After the composition interfaces are defined | |
| Top-Down | | 51-75% | Other | During system specification process. |
| Bottom-Up | | 51-75% | After the architecture is fully defined (contract phase) | |
| Top-Down | | 51-75% | Other | |

| Q3.1 | Q3.1_3_TEXT | Q3.2 | Q3.3 | Q3.3_4_TEXT |
|---|---|---|---|---|
| Top-Down,Bottom-Up | | | Other | Frequent update during project life time |
| Top-Down | | 26-50% | After the architecture is fully defined (contract phase) | |
| Top-Down | | 0-25% | After the composition interfaces are defined | |
| Top-Down,Bottom-Up | | 0-25% | After the component interfaces are defined | |
| Other | We claim Top-Down, but the actual deliveries so far seem kind of Middle-Out. | 0-25% | After the composition interfaces are defined | |
| Top-Down | | 51-75% | After the composition interfaces are defined | |
| Bottom-Up | | 76-100% | Other | n/a |

| Q3.1 | Q3.1_3_TEXT | Q3.2 | Q3.3 | Q3.3_4_TEXT |
|---|---|---|---|---|
| Top-Down,Bottom-Up | | 26-50% | After the composition interfaces are defined | |
| Top-Down | | 26-50% | After the component interfaces are defined | |
| Bottom-Up | | 0-25% | After the component interfaces are defined | |
| Top-Down,Bottom-Up | | 76-100% | After the architecture is fully defined (contract phase) | |
| Top-Down,Bottom-Up | | 26-50% | After the component interfaces are defined | |
| Bottom-Up | | 26-50% | After the architecture is fully defined (contract phase) | |
| Bottom-Up | | 51-75% | After the composition interfaces are defined | |

| Q3.1 | Q3.1_3_TEXT | Q3.2 | Q3.3 | Q3.3_4_TEXT |
|---|---|---|---|---|
| Top-Down,Bottom-Up | | 76-100% | Other | Wie generieren die RTE und nutzen diese fÃ¼r die Komponentenentwicklung. |
| | | 0-25% | | |
| Bottom-Up | | 0-25% | | |
| Top-Down,Bottom-Up | | 0-25% | After the component interfaces are defined | |
| Top-Down | | 51-75% | After the architecture is fully defined (contract phase) | |

| Q3.1 | Q3.1_3_TEXT | Q3.2 | Q3.3 | Q3.3_4_TEXT |
|---|---|---|---|---|
| Bottom-Up | | 51-75% | After the component interfaces are defined | |
| Top-Down | | 51-75% | After the composition interfaces are defined | |

| Q3.1 | Q3.1_3_TEXT | Q3.2 | Q3.3 | Q3.3_4_TEXT |
| --- | --- | --- | --- | --- |

| Q3.1 | Q3.1_3_TEXT | Q3.2 | Q3.3 | Q3.3_4_TEXT |
|---|---|---|---|---|
| Top-Down | | 76-100% | After the architecture is fully defined (contract phase) | |
| Top-Down,Bottom-Up | | 51-75% | After the component interfaces are defined | |
| Top-Down,Bottom-Up | | 26-50% | Other | It's an iteration process. |
| Top-Down | | 0-25% | After the architecture is fully defined (contract phase) | |
| Top-Down | | 26-50% | After the architecture is fully defined (contract phase) | |

| Q3.1 | Q3.1_3_TEXT | Q3.2 | Q3.3 | Q3.3_4_TEXT |
|---|---|---|---|---|
| Top-Down,Bottom-Up | | 76-100% | After the composition interfaces are defined | |
| Bottom-Up | | 51-75% | After the architecture is fully defined (contract phase) | |
| Top-Down | | 76-100% | After the composition interfaces are defined | |
| Top-Down,Bottom-Up | | 26-50% | After the composition interfaces are defined | |



| Q3.4 | Q3.4_4_TEXT | Q3.5 | Q3.6 | Q3.6_3_TEXT |
|---|---|---|---|---|
| Other | The RTE is generated automatically in a continuous integration chain | 10 | Split amongst the system and component teams | |
| After the component interfaces are defined | | 1 | Split amongst the system and component teams | |

| Q3.4 | Q3.4_4_TEXT | Q3.5 | Q3.6 | Q3.6_3_TEXT |
|---|---|---|---|---|
| After the composition interfaces are defined | | 100 | Split amongst the system and component teams | |
| Other | | 10 | All on the same team | |
| After the component interfaces are defined | | 30 | Split amongst the system and component teams | |
| After the component interfaces are defined | | 25 | Split amongst the system and component teams | |
| After the architecture is fully defined (contract phase) | | 5 | Split amongst the system and component teams | |
| Other | n.a. | 0 | Other | n.a. |
| After the component interfaces are defined | | 15 | All on the same team | |
| After the component interfaces are defined | | 15 | Split amongst the system and component teams | |
| After the component interfaces are defined | | 4 | Split amongst the system and component teams | |
| Other | While building | 5 | All on the same team | |

| Q3.4 | Q3.4_4_TEXT | Q3.5 | Q3.6 | Q3.6_3_TEXT |
|---|---|---|---|---|
| After the component interfaces are defined | | 99 | Split amongst the system and component teams | |
| After the architecture is fully defined (contract phase) | | 2 | All on the same team | |
| After the component interfaces are defined | | 10 | Other | One for each SW project. Big projects, have a hierarchy of SW architects. |
| After the component interfaces are defined | | 100 | Split amongst the system and component teams | |
| Other | | 3 | Other | |
| Other | Frequent update during project life time | 101 | Other | split over central teams for system and component design and teams belonging to specific projects |
| After the composition interfaces are defined | | 15 | Split amongst the system and component teams | |
| After the composition interfaces are defined | | 10 | Split amongst the system and component teams | |

| Q3.4 | Q3.4_4_TEXT | Q3.5 | Q3.6 | Q3.6_3_TEXT |
|---|---|---|---|---|
| After the architecture is fully defined (contract phase) | | 4 | Split amongst the system and component teams | |
| After the composition interfaces are defined | | 40 | Split amongst the system and component teams | |
| After the architecture is fully defined (contract phase) | | 10 | Split amongst the system and component teams | |
| After the component interfaces are defined | | 1 | Other | n/a |
| After the component interfaces are defined | | 50 | Split amongst the system and component teams | |
| After the component interfaces are defined | | 15 | All on the same team | |

| Q3.4 | Q3.4_4_TEXT | Q3.5 | Q3.6 | Q3.6_3_TEXT |
| --- | --- | --- | --- | --- |
| After the component interfaces are defined | | 0 | Split amongst the system and component teams | |
| Other | two steps 1. contract phase and final when components defined with all service ports from BSW as well | 20 | Split amongst the system and component teams | |
| After the component interfaces are defined | | 30 | All on the same team | |
| After the component interfaces are defined | | 1 | All on the same team | |
| After the component interfaces are defined | | 8 | Split amongst the system and component teams | |
| Other | Wir generieren die RTE uns nutzen diese fÃ¼r die Komponentenentwicklung. | 7 | Other | Aufgeteilt in System und Software. System ignoriert jedoch AUTOSAR weitgehend. |
| | | | Split amongst the system and component teams | |
| | | | Split amongst the system and component teams | |

| Q3.4 | Q3.4_4_TEXT | Q3.5 | Q3.6 | Q3.6_3_TEXT |
|---|---|---|---|---|
| After the composition interfaces are defined | | | | |
| After the architecture is fully defined (contract phase) | | 2 | Split amongst the system and component teams | |
| After the component interfaces are defined | | 5 | Split amongst the system and component teams | |

| Q3.4 | Q3.4_4_TEXT | Q3.5 | Q3.6 | Q3.6_3_TEXT |
|---|---|---|---|---|
| After the component interfaces are defined | | 4 | Split amongst the system and component teams | |

| Q3.4 | Q3.4_4_TEXT | Q3.5 | Q3.6 | Q3.6_3_TEXT |
| --- | --- | --- | --- | --- |
| After the component interfaces are defined | | | Split amongst the system and component teams | |
| After the composition interfaces are defined | | 150 | Split amongst the system and component teams | |

| Q3.4 | Q3.4_4_TEXT | Q3.5 | Q3.6 | Q3.6_3_TEXT |
|---|---|---|---|---|
| After the component interfaces are defined | | 10 | Split amongst the system and component teams | |
| | | 12 | All on the same team | |
| After the architecture is fully defined (contract phase) | | 10 | Split amongst the system and component teams | |
| After the component interfaces are defined | | 5 | Split amongst the system and component teams | |
| Other | Koninuierliche updates Ã¼ber die Prjektphase | 30 | Other | Ein Architekt pro DevTeam (4-7 Entwickler) + Architekten auf Stabsstellen |
| Other | stÃ¤ndig | 250 | Split amongst the system and component teams | |

| Q3.4 | Q3.4_4_TEXT | Q3.5 | Q3.6 | Q3.6_3_TEXT |
|---|---|---|---|---|
| After the architecture is fully defined (contract phase) | | | Split amongst the system and component teams | |

| Q3.7 | Q3.8 | Q3.9 | Q3.9_10_TEXT | Q3.9_11_TEXT |
|---|---|---|---|---|
| 30 | 5 | ADAS,Powertrain | | |
| 1 | 1 | ADAS,Occupant and Pedestrian Safety,Telematics | | |
| 30 | 20 | ADAS,Body Comfort,Telematics | | |
| 30 | 5 | ADAS,Body Comfort,Chassis,Powertrain,Safety (ABS, Airbag, etc),Telematics,Non-Automotive | | |
| 100 | 10 | ADAS,Body Comfort,Chassis,Occupant and Pedestrian Safety,Powertrain,Safety (ABS, Airbag, etc),Telematics | | |

| Q3.7 | Q3.8 | Q3.9 | Q3.9_10_TEXT | Q3.9_11_TEXT |
|---|---|---|---|---|
| 100 | 100 | ADAS,Body Comfort,Chassis,Occupant and Pedestrian Safety,Powertrain,Telematics | | |
| 20 | 20 | ADAS | | |
| 0 | 0 | Powertrain | | |
| 50 | 5 | Human Machine Interface (HMI),Powertrain | | |
| 5 | 3 | Chassis,Powertrain | | |
| 20 | 0 | Body Comfort,Chassis,Powertrain | | |
| 300 | 20 | Body Comfort,Chassis,Powertrain,Safety (ABS, Airbag, etc) | | |
| 10 | 5 | ADAS,Human Machine Interface (HMI),Powertrain,Telematics | | |
| 20 | 3 | ADAS,Human Machine Interface (HMI),Powertrain,Telematics | | |
| 120 | 5 | ADAS,Powertrain,Other | | eMobilty components: OBC and BMS. |

| Q3.7 | Q3.8 | Q3.9 | Q3.9_10_TEXT | Q3.9_11_TEXT |
|---|---|---|---|---|
| 10 | 5 | ADAS,Body Comfort,Chassis,Powertrain,Safety (ABS, Airbag, etc) | | |
| 3 | 2 | Powertrain | | |
| 400 | 40 | Body Comfort,Chassis,Powertrain | | |
| 400 | 10 | Other | | Engine |
| 500 | 20 | | | |
| 50 | 5 | Non-Automotive | Power System Distribution | |
| 1000 | 20 | Powertrain | | |
| 100 | 100 | Safety (ABS, Airbag, etc) | | |
| 10 | 3 | ADAS,Powertrain,Telematics | | |

| Q3.7 | Q3.8 | Q3.9 | Q3.9_10_TEXT | Q3.9_11_TEXT |
|---|---|---|---|---|
| 100 | | ADAS | | |
| 40 | 5 | Body Comfort,Telematics | | |
| 5 | 2 | ADAS | | |
| 40 | 3 | ADAS,Body Comfort,Chassis,Human Machine Interface (HMI),Multimedia,Occupant and Pedestrian Safety,Powertrain,Safety (ABS, Airbag, etc),Telematics | | |
| 20 | 10 | ADAS,Body Comfort,Powertrain | | |
| 5 | 0 | Powertrain | | |
| 8 | | ADAS,Body Comfort,Chassis,Powertrain,Safety (ABS, Airbag, etc) | | |
| 16 | 1 | Other | | BMS, wird teilweise zu Karosserie, teilweise zum Antriebsstrang gezÃ¤hlt. |

| Q3.7 | Q3.8 | Q3.9 | Q3.9_10_TEXT | Q3.9_11_TEXT |
|---|---|---|---|---|
| | | Powertrain | | |
| 30 | 1 | Body Comfort,Multimedia,Telematics | | |
| 5 | 2 | ADAS | | |

| Q3.7 | Q3.8 | Q3.9 | Q3.9_10_TEXT | Q3.9_11_TEXT |
| --- | --- | --- | --- | --- |
| 40 | 20 | Body Comfort,Chassis | | |
| 6 | 2 | ADAS,Body Comfort,Chassis,Powertrain | | |

| Q3.7 | Q3.8 | Q3.9 | Q3.9_10_TEXT | Q3.9_11_TEXT |
|---|---|---|---|---|
| | | Human Machine Interface (HMI),Powertrain | | |
| 400 | 10 | ADAS,Body Comfort,Chassis,Multimedia,Powertrain,Safety (ABS, Airbag, etc) | | |

| Q3.7 | Q3.8 | Q3.9 | Q3.9_10_TEXT | Q3.9_11_TEXT |
|---|---|---|---|---|
| 1000 | 100 | Powertrain | | |
| | | ADAS,Body Comfort,Chassis,Powertrain,Safety (ABS, Airbag, etc) | | |
| 5 | 3 | ADAS,Body Comfort,Chassis,Human Machine Interface (HMI),Multimedia,Occupant and Pedestrian Safety,Powertrain,Safety (ABS, Airbag, etc),Telematics | | |
| 10 | 2 | Body Comfort,Powertrain,Safety (ABS, Airbag, etc) | | |
| 30 | 3 | Body Comfort,Chassis,Powertrain | | |
| 150 | | ADAS,Body Comfort,Chassis | | |

| Q3.7 | Q3.8 | Q3.9 | Q3.9_10_TEXT | Q3.9_11_TEXT |
|---|---|---|---|---|
| 70 | 20 | ADAS,Body Comfort,Chassis,Occupant and Pedestrian Safety,Powertrain,Safety (ABS, Airbag, etc),Telematics,Non-Automotive | | |

| Q3.10 | Q3.10_5_TEXT | Q3.11 | Q3.11_1_TEXT |
|---|---|---|---|
| OEM/Customer requirements | | Architecture,Diagnostics,Integration,Model based development,Validation and verification | Enterprise Architect |
| Functional safety goals,Reuse of components across programs and platforms | | Architecture,Diagnostics,Model based development,Validation and verification | |
| Reuse of components across programs and platforms | | Architecture,Diagnostics,Calibration data management,Model based development | Enterprise Architect |
| Functional safety goals,Reduce reliance on custom architecture,Reuse of components across programs and | | Architecture,Diagnostics,Integration,Calibration data management,Hand code development,Model based development,Validation and verification | Hirain INTEWORK EAS |

| Q3.10 | Q3.10_5_TEXT | Q3.11 | Q3.11_1_TEXT |
|---|---|---|---|
| platforms,OEM/Customer requirements | | | |
| OEM/Customer requirements | | Architecture,Diagnostics,Integration,Calibration data management,Model based development | Preevision |
| OEM/Customer requirements | | Architecture,Diagnostics,Calibration data management,Hand code development,Model based development,Validation and verification | PREEvison and Autosar builder |
| Functional safety goals,Reduce reliance on custom architecture,Reuse of components across programs and platforms,OEM/Customer requirements | | Architecture | EA |
| OEM/Customer requirements | | | |
| OEM/Customer requirements | | Architecture,Diagnostics,Calibration data management,Hand code development,Model based development,Validation and verification | DaVinci |
| Functional safety goals,Reuse of components across programs and platforms,OEM/Customer requirements | | Architecture,Diagnostics,Integration,Calibration data management,Hand code development,Model based development,Validation and verification | Enterprise Architect |
| Reduce reliance on custom architecture,Reuse of components across programs and | | Architecture,Diagnostics,Integration,Calibration data management,Hand code development,Model based development,Validation and verification | DaVinci, ISOLAR |

| Q3.10 | Q3.10_5_TEXT | Q3.11 | Q3.11_1_TEXT |
|---|---|---|---|
| platforms,OEM/Customer requirements | | | |
| Functional safety goals,Reduce reliance on custom architecture,Reuse of components across programs and platforms | | Architecture,Diagnostics,Integration,Calibration data management,Model based development,Validation and verification | PREEvision |
| Reuse of components across programs and platforms,OEM/Customer requirements | | | |
| OEM/Customer requirements | | Architecture,Diagnostics,Integration,Calibration data management,Model based development | Vector |
| OEM/Customer requirements | | Architecture,Diagnostics,Model based development,Validation and verification | Custom + Davinici Developer |
| Functional safety goals,Reuse of components across programs and platforms,OEM/Customer requirements | | Architecture,Diagnostics,Integration,Hand code development,Model based development,Validation and verification | |
| OEM/Customer requirements | | Architecture,Diagnostics,Integration,Validation and verification,Other | |

| Q3.10 | Q3.10_5_TEXT | Q3.11 | Q3.11_1_TEXT |
|---|---|---|---|
| Reduce reliance on custom architecture,Reuse of components across programs and platforms,OEM/Customer requirements,Other | usage of of the shelf commercial tools for SW development avoidance of customer specific solutions | Architecture,Diagnostics,Integration,Calibration data management,Hand code development,Model based development,Validation and verification | PreeVision, System Composer |
| Functional safety goals,Reduce reliance on custom architecture,OEM/Customer requirements | | Architecture,Integration,Calibration data management,Model based development,Validation and verification,Other | Preevision |
| Functional safety goals,Reduce reliance on custom architecture,OEM/Customer requirements | | Architecture,Integration,Model based development,Validation and verification | PREEvision |
| Reduce reliance on custom architecture,Reuse of components across programs and platforms,OEM/Customer requirements | | Architecture,Hand code development,Model based development,Validation and verification | PREEvision and System Composer |
| Reuse of components across programs and platforms,OEM/Customer requirements | | Architecture,Model based development | PREEvision |
| Functional safety goals,Reuse of components across programs and platforms,OEM/Customer requirements | | Diagnostics | |

| Q3.10 | Q3.10_5_TEXT | Q3.11 | Q3.11_1_TEXT |
| --- | --- | --- | --- |
| OEM/Customer requirements | | Other | |
| Functional safety goals,Reduce reliance on custom architecture,Reuse of components across programs and platforms,OEM/Customer requirements | | Architecture,Diagnostics,Integration,Calibration data management,Model based development,Validation and verification | Vector PREEVision, Rhapdody, Vector DaVinci Developer, TA Toolsuite |
| Functional safety goals,Reduce reliance on custom architecture,OEM/Customer requirements | | Diagnostics,Integration,Hand code development | |
| Functional safety goals,Reduce reliance on custom architecture,Reuse of components across programs and platforms,OEM/Customer requirements | | | |
| Other | we provide Autosar stacks and solutions | Other | |
| Functional safety goals,Reduce reliance on custom architecture,Reuse of components across programs and | | Architecture,Diagnostics,Integration,Calibration data management,Hand code development,Model based development,Validation and verification | EA |

| Q3.10 | Q3.10_5_TEXT | Q3.11 | Q3.11_1_TEXT |
|---|---|---|---|
| platforms,OEM/Customer requirements | | | |
| OEM/Customer requirements | | Architecture,Diagnostics,Calibration data management,Model based development,Validation and verification | Vector Davinci Developper |
| OEM/Customer requirements | | Architecture,Diagnostics,Integration,Hand code development,Model based development | |
| OEM/Customer requirements | | Architecture,Diagnostics,Hand code development,Model based development | Rhapsody, Davinci Developer |
| Functional safety goals,Reduce reliance on custom architecture,OEM/Customer requirements | | | |
| OEM/Customer requirements | | | |
| Functional safety goals,Reduce reliance on custom architecture,Reuse of components across programs and | | | |

| Q3.10 | Q3.10_5_TEXT | Q3.11 | Q3.11_1_TEXT |
|---|---|---|---|
| platforms,OEM/Customer requirements | | | |
| Reduce reliance on custom architecture,Reuse of components across programs and platforms,OEM/Customer requirements | | Architecture,Hand code development,Model based development | DAVINCI |
| Reuse of components across programs and platforms,OEM/Customer requirements | | Architecture,Diagnostics,Integration,Calibration data management,Hand code development,Model based development | EA |

| Q3.10 | Q3.10_5_TEXT | Q3.11 | Q3.11_1_TEXT |
|---|---|---|---|
| Reduce reliance on custom architecture,Reuse of components across programs and platforms,OEM/Customer requirements | | | |

| Q3.10 | Q3.10_5_TEXT | Q3.11 | Q3.11_1_TEXT |
|---|---|---|---|
| Reduce reliance on custom architecture,Reuse of components across programs and platforms,OEM/Customer requirements | | Model based development | |

| Q3.10 | Q3.10_5_TEXT | Q3.11 | Q3.11_1_TEXT |
|---|---|---|---|
| Functional safety goals,Reduce reliance on custom architecture,Reuse of components across programs and platforms,OEM/Customer requirements | | Architecture,Model based development | Da Vinci generator |
| OEM/Customer requirements | | Architecture,Calibration data management,Model based development | isolar-A |
| Functional safety goals,Reuse of components across programs and platforms,OEM/Customer requirements | | | |
| Functional safety goals,Reduce reliance on custom architecture,Reuse of components across programs and platforms,OEM/Customer requirements | | Architecture,Diagnostics,Integration,Hand code development,Model based development,Validation and verification | Enterprise Architect |

| Q3.10 | Q3.10_5_TEXT | Q3.11 | Q3.11_1_TEXT |
|---|---|---|---|
| Functional safety goals,Reduce reliance on custom architecture,Reuse of components across programs and platforms | | Architecture,Integration,Calibration data management,Hand code development,Model based development | PREEVision |
| Reduce reliance on custom architecture,Reuse of components across programs and platforms,OEM/Customer requirements | | Architecture,Diagnostics,Integration,Calibration data management,Hand code development,Model based development,Validation and verification | 2 |
| Reuse of components across programs and platforms | | Architecture,Diagnostics,Integration,Hand code development,Model based development,Validation and verification | Rapsody |
| Functional safety goals,Reduce reliance on custom architecture,Reuse of components across programs and platforms | | Architecture,Diagnostics,Integration,Calibration data management,Hand code development,Model based development,Validation and verification | |

| Q3.11_2_TEXT | Q3.11_3_TEXT | Q3.11_4_TEXT | Q3.11_5_TEXT | Q3.11_6_TEXT | Q3.11_7_TEXT | Q3.11_8_TEXT |
|---|---|---|---|---|---|---|
| CANdela Sutdio | Davici Tools | | | Matlab Simulink & StateFlow | Vector Tools and others | |
| CANoe.DiVa | | Canape | | Simulink | | |
| Hirain INTEWORK EAS Configurator | Hirain INTEWORK EAS | Hirain INTEWORK EAS | Hirain INTEWORK EAS | MATLABï¼ŒHirain INTEWORK EAS SWCDesigner | | |
| CANdella | DaVinci, Tresos, VSx | CANape | | Matlab, Simulink | | |
| Davinci, Vsx, EB, ISOLAR | | INCA | C | Matlab | Vectorcast, IBM, polyspace | |
| Candela | | Canape | | Matlab | Polyspace | |
| vector Tools | Jenkins | creo | tresosStudio, Editoren | Matlab/SimuLink + TargetLink | Parasoft, TPT, MXAM, MXRAY, Astree | |
| CANdela | DaVinci, ISOLAR | CDM studio | IDE | MathWorks | CANape, CANoe | |

| Q3.11_2_TEXT | Q3.11_3_TEXT | Q3.11_4_TEXT | Q3.11_5_TEXT | Q3.11_6_TEXT | Q3.11_7_TEXT | Q3.11_8_TEXT |
|---|---|---|---|---|---|---|
| Candela Studio | Davinci, ISOLAR | CRETA | | SIMULINK | vTestStudio | |
| Vector | Vector | Vector | | Mathworks/Vector | | |
| Davinci configurator | | | | MATLAB/Simulink | CANoe + VtestStudio | |
| | Autosar Builder, ISOLAR A/B, DaVinci | | | Matlab | | |
| | Matlab | In House | | Matlab | Matlab | CANalyzer |
| | Davinci Configurator | | | Matlab | Matlab | |

| Q3.11_2_TEXT | Q3.11_3_TEXT | Q3.11_4_TEXT | Q3.11_5_TEXT | Q3.11_6_TEXT | Q3.11_7_TEXT | Q3.11_8_TEXT |
|---|---|---|---|---|---|---|
| | | | Eclipse | Simulink | Simulink | |
| | | | | Mathworks | | |
| | | | | | | Vector, EB; |
| Candela Studio, Vector PREEVision | Vector DaVinci Configurator | CANape | | MATLAB Simulink, dSpace TargetLink | VectorCAST, CANoe, TESSY, CANape, ECU Test, TA Toolsuite, Gliwa T1 | |
| | | | | | | depends on customer demands |
| Proprietary | Tresos, DaVinci | | Eclipse | Matlab | Tessy, Polyspace | |

| Q3.11_2_TEXT | Q3.11_3_TEXT | Q3.11_4_TEXT | Q3.11_5_TEXT | Q3.11_6_TEXT | Q3.11_7_TEXT | Q3.11_8_TEXT |
|---|---|---|---|---|---|---|
| Vector Candela | | Vector CanapÃ© | | Mathworks | In house sequencer | |
| ODXStudio und CANdela Studio | | | Eclipse/ Notepad++/ Visual Studio, â€¦ | Embedded Coder, Fixed Point Toolbox, AUTOSAR BlockSet, â€¦ | | |
| | | | Tasking | Simulink | | |

| Q3.11_2_TEXT | Q3.11_3_TEXT | Q3.11_4_TEXT | Q3.11_5_TEXT | Q3.11_6_TEXT | Q3.11_7_TEXT | Q3.11_8_TEXT |
|---|---|---|---|---|---|---|
| Canoe | Git | Canape | Notepad++ | Simulink | | |

| Q3.11_2_TEXT | Q3.11_3_TEXT | Q3.11_4_TEXT | Q3.11_5_TEXT | Q3.11_6_TEXT | Q3.11_7_TEXT | Q3.11_8_TEXT |
|---|---|---|---|---|---|---|
| | | | | MATLAB 2020 | | |

| Q3.11_2_TEXT | Q3.11_3_TEXT | Q3.11_4_TEXT | Q3.11_5_TEXT | Q3.11_6_TEXT | Q3.11_7_TEXT | Q3.11_8_TEXT |
|---|---|---|---|---|---|---|
| | | | | IBM Rhapsody | | |
| | | vCDM | | ASCET, Simulink | | |
| Vector Adaptive microsar | Vector Adaptive microsar | | Eclipse | Davinci | Vectorcast | |
| | isoft ORIENTAIS | CANape INCA | | Matlab/simulink,ORIENTAIS | | |
| 2 | 2 | 2 | 3 | 1 | 4 | |
| div | div | | C | Matlab | div | |

| Q3.11_2_TEXT | Q3.11_3_TEXT | Q3.11_4_TEXT | Q3.11_5_TEXT | Q3.11_6_TEXT | Q3.11_7_TEXT | Q3.11_8_TEXT |
|---|---|---|---|---|---|---|



| Q3.12 | Q3.12_5_TEXT | Q3.13 | Q3.13_7_TEXT | Q3.14 |
|---|---|---|---|---|
| Automotive SPICE (ISO/IEC 15504) | | ISO 26262 - Automotive | | QM,ASIL A,ASIL B |
| Automotive SPICE (ISO/IEC 15504),Capability Maturity Model Integration/Capability Maturity Model Integration (CMM/CMMI) | | IEC 61508 - General,ISO 26262 - Automotive | | ASIL B |

| Q3.12 | Q3.12_5_TEXT | Q3.13 | Q3.13_7_TEXT | Q3.14 |
|---|---|---|---|---|
| Automotive SPICE (ISO/IEC 15504) | | ISO 26262 - Automotive | | QM |
| Capability Maturity Model Integration/Capability Maturity Model Integration (CMM/CMMI) | | ISO 26262 - Automotive | | ASIL D |
| Automotive SPICE (ISO/IEC 15504),Capability Maturity Model Integration/Capability Maturity Model Integration (CMM/CMMI) | | ISO 26262 - Automotive | | QM,ASIL A,ASIL B,ASIL C,ASIL D |
| Automotive SPICE (ISO/IEC 15504),Capability Maturity Model Integration/Capability Maturity Model Integration (CMM/CMMI) | | ISO 26262 - Automotive | | QM,ASIL A,ASIL B,ASIL C,ASIL D |
| Automotive SPICE (ISO/IEC 15504) | | ISO 26262 - Automotive | | ASIL B |
| Automotive SPICE (ISO/IEC 15504) | | ISO 26262 - Automotive | | QM,ASIL A,ASIL B,ASIL C,ASIL D |
| Automotive SPICE (ISO/IEC 15504) | | ISO 26262 - Automotive | | ASIL D |
| Automotive SPICE (ISO/IEC 15504) | | ISO 26262 - Automotive | | ASIL B |
| Automotive SPICE (ISO/IEC 15504) | | ISO 26262 - Automotive | | QM,ASIL A,ASIL B,ASIL C,ASIL D |
| | | ISO 26262 - Automotive | | QM,ASIL B,ASIL D |

| Q3.12 | Q3.12_5_TEXT | Q3.13 | Q3.13_7_TEXT | Q3.14 |
|---|---|---|---|---|
| | | | | |
| Automotive SPICE (ISO/IEC 15504) | | ISO 26262 - Automotive | | QM,ASIL A,ASIL B |
| Automotive SPICE (ISO/IEC 15504) | | ISO 26262 - Automotive | | ASIL B |
| Automotive SPICE (ISO/IEC 15504),Capability Maturity Model Integration/Capability Maturity Model Integration (CMM/CMMI) | | ISO 26262 - Automotive | | QM,ASIL A,ASIL B,ASIL C |
| Automotive SPICE (ISO/IEC 15504) | | ISO 26262 - Automotive | | ASIL D |
| | | | | |
| Automotive SPICE (ISO/IEC 15504) | | ISO 26262 - Automotive | | QM,ASIL A,ASIL B,ASIL C,ASIL D |
| Automotive SPICE (ISO/IEC 15504),Test Maturity Model/Test Maturity Model Integration (TMM/TMMI) | | ISO 26262 - Automotive | | ASIL B |
| Capability Maturity Model Integration/Capability Maturity Model Integration (CMM/CMMI) | | ISO 26262 - Automotive | | |

| Q3.12 | Q3.12_5_TEXT | Q3.13 | Q3.13_7_TEXT | Q3.14 |
|---|---|---|---|---|
| Automotive SPICE (ISO/IEC 15504) | | | | |
| Automotive SPICE (ISO/IEC 15504),Capability Maturity Model Integration/Capability Maturity Model Integration (CMM/CMMI) | | ISO 26262 - Automotive | | QM,ASIL A,ASIL B,ASIL C,ASIL D |
| Automotive SPICE (ISO/IEC 15504) | | ISO 26262 - Automotive | | ASIL D |
| Automotive SPICE (ISO/IEC 15504) | | ISO 26262 - Automotive | | QM,ASIL B |
| Automotive SPICE (ISO/IEC 15504) | | ISO 26262 - Automotive | | QM,ASIL B,ASIL D |
| Automotive SPICE (ISO/IEC 15504) | | | | |
| Automotive SPICE (ISO/IEC 15504) | | ISO 26262 - Automotive | | QM,ASIL A,ASIL B,ASIL C |
| Automotive SPICE (ISO/IEC 15504) | | IEC 61508 - General,ISO 26262 - Automotive | | ASIL D |

| Q3.12 | Q3.12_5_TEXT | Q3.13 | Q3.13_7_TEXT | Q3.14 |
|---|---|---|---|---|
| Automotive SPICE (ISO/IEC 15504) | | ISO 26262 - Automotive | | QM,ASIL A,ASIL B,ASIL C,ASIL D |
| Automotive SPICE (ISO/IEC 15504) | | ISO 26262 - Automotive | | ASIL D |
| Automotive SPICE (ISO/IEC 15504) | | ISO 26262 - Automotive | | QM,ASIL A,ASIL B |
| Automotive SPICE (ISO/IEC 15504) | | ISO 26262 - Automotive | | QM,ASIL A,ASIL B |
| Automotive SPICE (ISO/IEC 15504) | | ISO 26262 - Automotive | | QM,ASIL B,ASIL D |
| Automotive SPICE (ISO/IEC 15504) | | ISO 26262 - Automotive | | ASIL A,ASIL B |
| Automotive SPICE (ISO/IEC 15504) | | ISO 26262 - Automotive | | ASIL D |

| Q3.12 | Q3.12_5_TEXT | Q3.13 | Q3.13_7_TEXT | Q3.14 |
|---|---|---|---|---|
| Automotive SPICE (ISO/IEC 15504),Capability Maturity Model Integration/Capability Maturity Model Integration (CMM/CMMI) | | ISO 26262 - Automotive | | QM,ASIL A,ASIL B,ASIL C |
| Automotive SPICE (ISO/IEC 15504) | | ISO 26262 - Automotive | | QM,ASIL A,ASIL B |

| Q3.12 | Q3.12_5_TEXT | Q3.13 | Q3.13_7_TEXT | Q3.14 |
| --- | --- | --- | --- | --- |

| Q3.12 | Q3.12_5_TEXT | Q3.13 | Q3.13_7_TEXT | Q3.14 |
|---|---|---|---|---|
| | | ISO 26262 - Automotive | | ASIL A,ASIL C |
| Automotive SPICE (ISO/IEC 15504),Performance Management Maturity Model,Test Maturity Model/Test Maturity Model Integration (TMM/TMMI) | | IEC 62061 - Manufacturing,ISO 26262 - Automotive | | QM,ASIL A,ASIL B,ASIL C,ASIL D |
| | | ISO 26262 - Automotive | | ASIL D |
| Automotive SPICE (ISO/IEC 15504) | | ISO 26262 - Automotive | | ASIL D |
| Automotive SPICE (ISO/IEC 15504),Capability Maturity Model Integration/Capability Maturity Model Integration (CMM/CMMI) | | ISO 26262 - Automotive | | QM,ASIL C,ASIL D |
| Automotive SPICE (ISO/IEC 15504) | | ISO 26262 - Automotive | | QM |
| Automotive SPICE (ISO/IEC 15504) | | ISO 26262 - Automotive | | ASIL D |
| Automotive SPICE (ISO/IEC 15504) | | ISO 26262 - Automotive | | QM,ASIL A,ASIL B,ASIL C,ASIL D |

| Q3.12 | Q3.12_5_TEXT | Q3.13 | Q3.13_7_TEXT | Q3.14 |
|---|---|---|---|---|
| Automotive SPICE (ISO/IEC 15504) | | ISO 26262 - Automotive | | QM,ASIL A,ASIL B,ASIL C,ASIL D |
| Automotive SPICE (ISO/IEC 15504),Capability Maturity Model Integration/Capability Maturity Model Integration (CMM/CMMI),Performance Management Maturity Model | | IEC 62061 - Manufacturing,IEC 62304 - Medical Device,ISO 26262 - Automotive | | QM,ASIL A,ASIL B,ASIL C,ASIL D |



| Q4.1 | Q4.1_13_TEXT | Q4.2 | Q4.3 | Q4.4 | Q4.5 |
|---|---|---|---|---|---|
| Informatics | | Spain | Battery Management Systems<br>Chargers<br>Shifter and Gear Box Actuator<br>Rear View Cameras<br>Surround view Systems<br>Camera Monitoring Systems (eMirrors) | Transversal support as software expert | 5 |
| Electronics | | China | ADAS | Developer director | 2 |

| Q4.1 | Q4.1_13_TEXT | Q4.2 | Q4.3 | Q4.4 | Q4.5 |
|---|---|---|---|---|---|
| Other | Computer Science | South Korea | I used AUTOSAR Adaptive on Telematics and Cluster ECU development | Project Leader | 4 |
| Automotive | | China | we can provide full AUTOSAR softwareï¼Œtools and services to many gloable customers. meanwhile we can provide almost all ECU cover whole car. | Principal responsible person | 10 |
| Electronics | | India | | Architect | 10 |
| Automotive | | India | Majorly worked in body control projects | Architect | 14 |
| Automotive | | India | | | 7 |
| Automotive | | Germany | In den Tools ADD, PACES, Aramis | | 12 |
| Electronics | | Germany | | Team- Lead | 10 |

| Q4.1 | Q4.1_13_TEXT | Q4.2 | Q4.3 | Q4.4 | Q4.5 |
|---|---|---|---|---|---|
| Automotive | | Germany | Mechatronische Teilsysteme im Bereich Fahrwerk (Lenkung, Fahrwerksaktorik) und Antriebsstrang (Hybridmodule, elektrische Achsen) fuer PKW/LKW mit - typischerweise - CAN-Anbindung an Bordnetz / Domain Controller. | Teamleiter fuer wiederverwendbare Automotive Embedded Software | 15 |
| Electronics | | Spain | | Architect | 9 |
| Physics | | Spain | Domain control architecture | Software Architect | 6 |
| Electronics | | Romania | | SW Dev, Product Owner, Technical Lead | 7 |

| Q4.1 | Q4.1_13_TEXT | Q4.2 | Q4.3 | Q4.4 | Q4.5 |
|---|---|---|---|---|---|
| Electronics | | Germany | Telematics Gateway - Internal platform<br>MGU Head unit infotainment platform - BMW<br>Instrument cluster - Volvo<br>Instrument cluster - BMW<br>Reference integration for BMW AUTOSAR Core (BAC)<br>Surround-view Camera - Daimler | Project Manager<br>Architect / Project Manager<br>Developer / Integrator / Project Manager<br>Developer / Integrator / Project Manager<br>Developer / Integrator<br>Developer / Integrator | 10 |
| Industrial | | Spain | emobility projects: battery management systems and chargers. | SW architect. | 5 |
| Electronics | | South Korea | . | Autosar Integration and System requirements design | 5 |
| Electronics | | India | | Developer | 4 |
| Electronics | | Germany | Platform development<br>Engine controller<br>Domain controller | SW Architect | 17 |

| Q4.1 | Q4.1_13_TEXT | Q4.2 | Q4.3 | Q4.4 | Q4.5 |
|---|---|---|---|---|---|
| Electronics | | India | Component development of Engine Management System | Developing Autosar Based tools for Developers | 5 |
| Other | Computer Engineering | United States of America | Converting "in-house" subsystem architecture to AUTOSAR | Subsystem Architect | 2 |
| Mathematics | | United States of America | Distributed network control system for control of microgrids | MBD leader and Software Architect | 2 |
| Mathematics | | United States of America | Automotive embedded controls | Architect | 3 |
| Automotive | | India | Development of memory and diagnostic modules | developer | 3 |
| Electronics | | Germany | ADAS, BEV, PHEV, | COM, DEM, DCM, NvM, ... BSW; | 10 |

| Q4.1 | Q4.1_13_TEXT | Q4.2 | Q4.3 | Q4.4 | Q4.5 |
|---|---|---|---|---|---|
| Automotive | | Germany | | | 6 |
| Telecommunications | | India | Engine ECU, TCU, BCM ECU devellopment | PO, TL | 9 |
| Automotive | | Japan | | | 3 |
| Other | computer science | Sweden | | | 14 |
| Electronics | | India | Automated Manual Transmission | '- SW Development and Integration | 2 |
| Informatics | | Belgium | Transmission control unit | BSW responsible | 2 |
| Automotive | | Germany | | Projektleiter | 15 |
| Other | Elektro und Informationstechnik | Germany | BMS, zentrales SteuergerÃ¤t fÃ¼r Elektroantriebsstrang, FlexRay Evaluierung | Leitender Softwareingenieur | 6 |
| Electronics | | United States of America | | | |

| Q4.1 | Q4.1_13_TEXT | Q4.2 | Q4.3 | Q4.4 | Q4.5 |
|---|---|---|---|---|---|
| Informatics | | Germany | | | |
| Automotive | | Canada | | | 5 |
| Informatics | | China | Intelligent Front Camera | Tech Leader | 3 |

| Q4.1 | Q4.1_13_TEXT | Q4.2 | Q4.3 | Q4.4 | Q4.5 |
|---|---|---|---|---|---|

| Q4.1 | Q4.1_13_TEXT | Q4.2 | Q4.3 | Q4.4 | Q4.5 |
|---|---|---|---|---|---|
| Electronics | | India | | | 2 |
| Automotive | | India | Handled CAN/COM interfaces for an AUTOMOTIVE OEM engine application | developer | 1 |

| Q4.1 | Q4.1_13_TEXT | Q4.2 | Q4.3 | Q4.4 | Q4.5 |
|---|---|---|---|---|---|
| Other | | China | | | |
| Informatics | | China | ECU, VCU, BMS, TCU, PEU | Manager | 10 |
| Automotive | | China | The CAN/CANFD network management strategy and the diagnostic and network communication protocols of ECU in whole vehicle projects. | The network and diagnostic engineer. | 4 |
| Electronics | | India | | Requirements Engineer , Architect , Developer | 2 |
| Electronics | | China | BCM/ABS/TCU/T-BOX | PM | 12 |
| Automotive | | Germany | Chassis & Powertrain, AUTOSAR Classic, 2-4 Core CPU | Projektleiter, Produktowner | 10 |
| Informatics | | Germany | Alle bis auf 16-bit Anwendungen | Entw. von Standards | 21 |

| Q4.1 | Q4.1_13_TEXT | Q4.2 | Q4.3 | Q4.4 | Q4.5 |
|---|---|---|---|---|---|
| Electronics | | Germany | | | 12 |

| Q4.6 |
|---|
| The methodology is more abstract, and the suggestions are more easy to understand. |
| AUTOSAR has strength on methodology but its standardization speed is somewhat slower recently compared with IT industries. |
| It needs more practice to accumulate experience. Currently, it mainly focuses on BSW |
| |
| Recent days finding it dificult to followup on spec deferences and new adoptations. Need to improve documention on non-autosar to autosar migrations. New concepts should have one document released may be aprt from cocept document. |
| |
| Wichtig in der Zukunft: Methodiken, Techniken zur einfachen Steuergeraete-Software Integration fuer komplexe, hochintegrierte  Steuergeraete und funktional (nicht komponentenweise) getriebenen Entwicklung. |

**Q4.6**

AUTOSAR Methodology needs to shift focus to continuous Engineering and usability.
Reducing Engineering feedback-loop times where the solution is created in incremental and iterative progress and re-work is minimized is more important than having a comprehensive process.

I think it is a good methodology which allows the technical coordination of large teams.

number of components and Compositions has a huge variety and depends on type of project and customer

most AUTOSAR Tools do not support the full potential of AUTOSAR with all its forma descriptions, many tools are not ergonomic if the project size becomes very large

Autosar methodology with Top down approach is the recommended way but practically its not possible. There is always some change down the flow so top need to be updated. Need some hybrid and faster way that defines faster software development process.



AUTOSAR is not a methodology. It is a standard and a layered architecture and implementation framework. We are trying to fit into the AUTOSAR world and have found many features/capabilities lacking in the services offered. The cost of tools, BSW , etc. are very expensive and have steep learning curve. All the tools are not well integrated, e.g. PREEvision, Simulink, CANdela, etc and the workflow is not seamless.

It's fundamentally sound, but requires architects and management to have some background in software engineering or computer science. Without that, the intermediate concepts take a long time and the subtle concepts may not be possible to understand.

NA

n/a

**Q4.6**

Durchgängige Umsetzung der Methodik erfordert extrem komplexe Toollandschaften und dürftige Toolinteroperabilität und schlechte Toolperformance ist eines der grÃ¶ÃŸten Probleme, welche die Projkete aus meiner Sicht stark einschränkt.

Weiterhin wurde vorallem bei dem Punkt ECU Integration der kollaborative Use-Case in Large-Scale Projekte nicht wirklich berücksichtigt und vorallem in Classic AUTOSAR Projekten lassen sich versch. Integrationsschritte nur schwer parallelisieren und es sind meist sehr erfahrene und breit aufgestellte Integratoren notwendig.

**Q4.6**

**Q4.6**

Adaptive autosar is being employed recently in the organization which provides a plethora of plug in functionalities.

Is the future for the AUTOMOTIVE industry. the challenge will be to integrate it with the complex neural networks and e powertrain.



It should be simplified.

No