Available online at www.sciencedirect.com

ScienceDirect

Procedia - Social and Behavioral Sciences 238 (2018) 149 – 156

Procedia
Social and Behavioral Sciences

SIM 2017 / 14th International Symposium in Management

Management of Automotive Business Teams and Product Evolution

Stephan Volker[a]*, Gabriela Prostean[b]*

[a,b] *Politehnica "University of Timisoara, Romania*

Abstract

In general, Risk-Assessments or discussions about sustainable development of a product have mostly a pure technical focus, in order to secure the factors of time, cost, quality, functionality and market acceptance. This paper will review the significance that at the start of the project life cycle, it is of vital importance to also consider the maintainability or evolution of the initial product-mission in order to secure the success of the product. Planned evolution and maintenance of a product is not restricted to prepare the product to carry potential new functions without being completely hardware- or software-architecture redesigned. Considering the automotive market cost pressure of products, it is usually not possible to allow hardware to be ready for more than the predefined set of functions. This research will consider product architectures and also focus on the review of (multi) company team structures, company capabilities (i.e. skills) and company resources (i.e. infrastructure), which need to be considered and development to be able to react to the new market opportunities.

Peer-review under responsibility of SIM 2017 / 14th International Symposium in Management.

Keywords: product maintenance; multi company; automotive projects; change mangement

1. Introduction

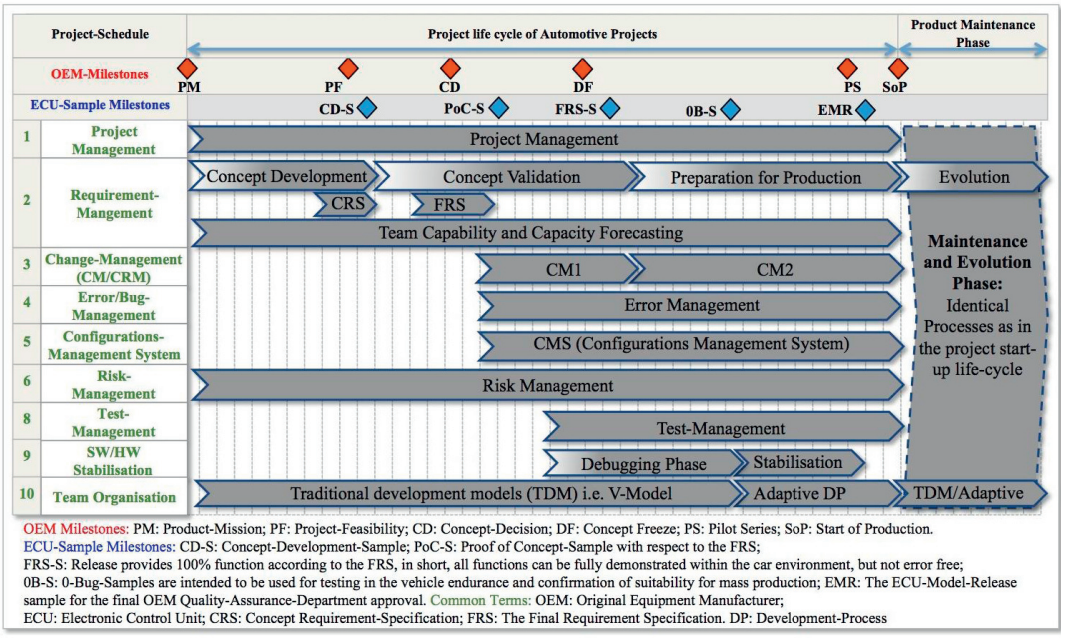
Automotive companies or researchers review project management organizational structures, such as requirement management processes [1-7], the V-model [8] or agile methodologies [8], from the start of a project until product launch to the market. The focuses of most papers are how to handle the "*Requirements becoming increasingly*

* Corresponding author:
a Stephan Volker, Phd student at "Politehnica" University of Timisoara, Romania
E-mail address: stephan-volker@htp-tel.de
b Gabriela Prostean, Professor at "Politehnica "University of Timisoara, Romania,
e-mail: gabriela.prostean@mpt.upt.ro, tel. +40-256-404-309

Peer-review under responsibility of SIM 2017 / 14th International Symposium in Management.
doi:10.1016/j.sbspro.2018.03.018

unstable to achieve shorter lead times and faster reaction to changing markets" [9, p.125] is not sufficient. IT companies consider two major product life cycles: the Development-Phase and the Maintenance-Phase [10]. Some of the software maintenance problem factors proposed by Jie-Cherng Chen, Sun-Jen Huang [10] are "*Previous studies have shown that one of the causes of software maintenance problems is that software maintainability is not often a major consideration during software design and implementation*". From personal experience this observation is also centered on the fact that a project budget allocations do not take into account the maintenance phase. The disregarded consideration of maintenance has the problem that possible reductions of maintenance costs are not part of the product feasibility and is difficult to estimate or forecast. Maintenance consists of SW/HW Bug-Fixing and product improvements driven by the constantly changing demands of the market. Requirement management mechanism of change request or bugs is discussed in several papers [1-7], but to forecast new product features depends on the markets, competitor survey an, history data and "*Estimations are based on individual judgement and as such highly subjective*" [9, p.125]. The project risk rises after the development phase with respect to the team capacity and capability far beyond the considered final phase, the maintenance or evolution phase of market introduction. In addition, commonly neglected is the consideration of far more complex project organizations, which are nowadays rapidly growing and established by fact that todays "*Organizations can rent what they were earlier forced to make or own. Generic concepts like rent translate into collaborative relationships with service providers who provide access to capabilities and resources otherwise not available to the organization*", [11, p.4].

This paper will review such complex organizational structures, were the developing teams consist of multi-company team and each sub-team is bound by different employee contracts. Those contacts defining the project life cycle, i.e. Automotive Projects are divided by a simplified examination in four phases "Definition of the Product-Mission", "Concept-Validation or Development-Phase" and the Debugging-Phase". Team members are usually specialized by engineering disciplines, such as developers and testers. Thus, developers usually leave the project at the final phase of the life cycle, the debugging phase. If the product requires no changes and to satisfies the needs of the market, that might be acceptable, but complex product such as mobile phones or automotive products require over their lifetime to be maintained. Thus a general IT or Automotive Projects life cycle should consist of an additional phase, the sustainable development phase. All product creation phases need to be supported by processes to handle the requirement management methods to be considered also.



OEM Milestones: PM: Product-Mission; PF: Project-Feasibility; CD: Concept-Decision; DF: Concept Freeze; PS: Pilot Series; SoP: Start of Production.
ECU-Sample Milestones: CD-S: Concept-Development-Sample; PoC-S: Proof of Concept-Sample with respect to the FRS;
FRS-S: Release provides 100% function according to the FRS, in short, all functions can be fully demonstrated within the car environment, but not error free;
0B-S: 0-Bug-Samples are intended to be used for testing in the vehicle endurance and confirmation of suitability for mass production; EMR: The ECU-Model-Release sample for the final OEM Quality-Assurance-Department approval. Common Terms: OEM: Original Equipment Manufacturer;
ECU: Electronic Control Unit; CRS: Concept Requirement-Specification; FRS: The Final Requirement Specification. DP: Development-Process

Figure 1. Automotive Project Milestone-Plan with Process-Introduction and Deliverables (adapted after [8, 23]).

2. Research Environment considerations

The research environment or exemplary model for all further the discussion is a complex automotive system, which has internal and external (i.e. "*connected car is a car that is equipped with Internet access"* [25]) network partners as shown in figure 2. Any system, such as the Driver-Assistance or Infotainment system is broken down into specialized development areas. Commonly, ECU's will be assigned and development by a specialized suppliers [1] section "Requirements for collaborative, multi-company ECM" [1].

The question arises during the product mission (PM, see fig. 1) und until the final implementation or development (FRS-S, see fig. 1) of a product is accomplished, *"…to own and operate assets, or conduct activities in-house. At other times, the sensible thing is to seek alternatives from the open market. As prevailing conditions change, boundaries of the firm contract or expand with decisions such as make, buy, or rent.*" [11, p.4]. The markets needs, the requirements or feature, which seem to improve the probability of survival of a product or business case is changing at a faster rate. Automotive products have therefore also a strong need to adapt to the far shorter life cycle or product update such as aftermarket devices. Thus the constant change of requirements keeps up the question to own or rent assets, skills or resources until the end-of-production.

The research project assumes that that all project partner have proven their potential to meet the project objectives which is part of an initial project launch supplier assessment, proving their company Management- and "domain knowledge in your own field" [12]. The supplier selection is part of the Supplier agreement management; but only the 1st tear supplier (i.e. navigation system developer) will be reviewed. The 2nd tear supplier (i.e. CPU supplier) might be assessed as well but is within the contractual responsibility of the 1st tear supplier. The innovation target will be a risk, but must be also considered during supplier selection [12].

All modifications of the requirement specification must be evaluated regarding all possible impacts, such as development schedule, budget and especially possible side effects, including impacts to of the network community partners. Another key issue to discuss is how to handle the impact of a must-have RfC, which appears in any project phase (see fig. 1).

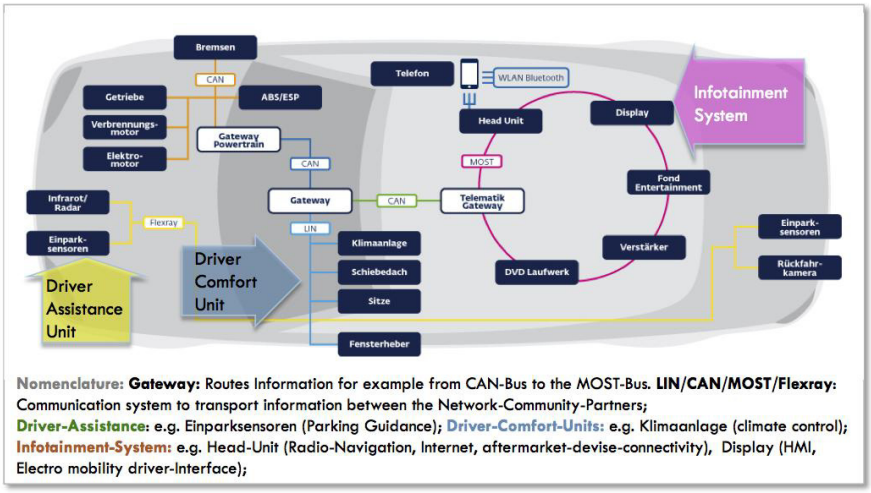


Figure 2. ECU Network Community [13]

3. Analysis of Multi Company Models

3.1. Business units capabilities and company resources

Figure 3 shows a model of a business unit with the necessary package of properties or assets to support the development process, in order to create a product or service. Taking for example the asset "Knowledge" and "People", it is obvious that those capabilities or resources must be planned to support the product development and to be ready in the given time [11, p.39]. From figure-1 it can be also be deduced that not all capabilities of the business unit can be defined during the Concept-Development phase. The business unit's capabilities must be reviewed particularly after the completion of the Final-Requirement-Specification (FRS). In fact, all the asset of the business unit should be under constant investigation, which is at least triggered via a Change-Management-Process if a change (RfC: Request for Change) of the FRS occurs.

The task of a change management (CM) process i.e. [2, 13] is also that the new requirement must be assigned to an expert for further investigation. The investigation should result in a RfC impact analysis, showing for example "*Market significance of the new Requirement*", *"Severity of the SW/HW Bug", "Technical Evaluation", Schedule impact", "Network-Partner are involved"* and *"Budget management"* [13, "*Table 1. Impact-Analysis (IA) Items and Assessments*"]. Reviewing several CM-Processes and from personal experience the RfC investigation concentrates only on only poor technical feasibility. The feasibility study or impact analysis should include the investigation of the capabilities (see figure 3) of the responsible business unit to deliver the RfC. If for example the capabilities Knowledge (skill) or Processes (CM) are not prepared to ensure a for instance the RfC analysis of the *"Schedule impact"* [13] the result of the investigation will only be limited be the status of the asset. However, if the CM process results in the information that one or several assets of a business unit are not sufficient to create the desired value, this information can be used to plan an adequate remedy.

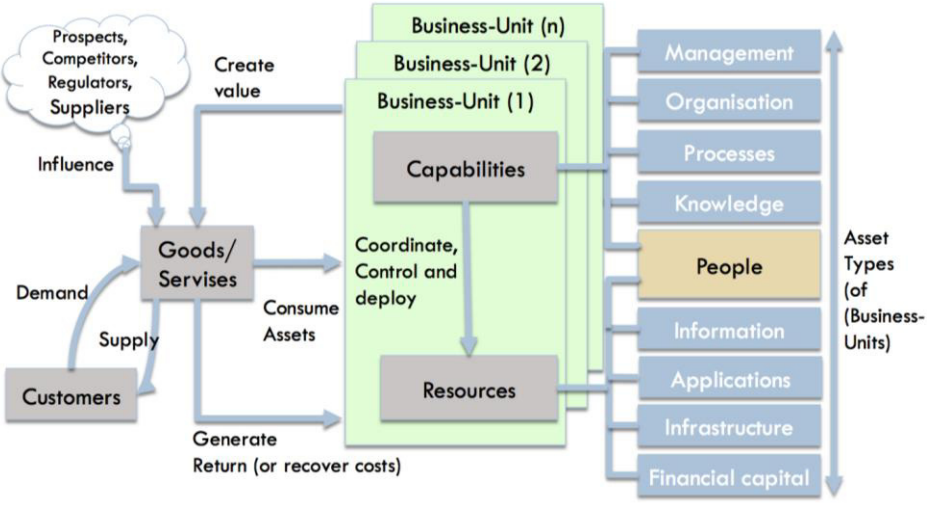


Figure 3. Business units are coordinated goal-driven collections of assets, adapted after [11, p.39]

3.2. Analysis of Multi Company Models

Section "Research Environment considerations" describes that automotive projects or ECU developments are divided into specialized development areas (see figure 2), which are given to several suppliers or business units as exemplified illustrated in figure 4.

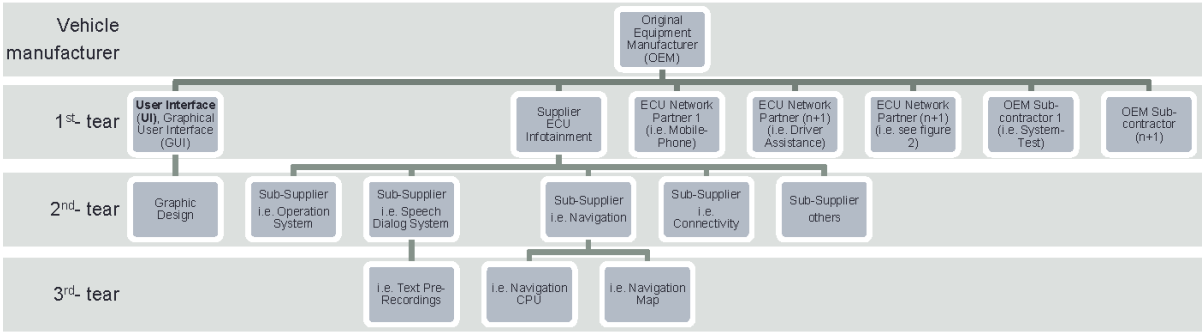


Figure 4. Example of Multi Company Models [23]

The sourcing or business out-sourcing [18] activity, start after definition of the Product-Mission. Simplified, as already stated the vehicle is broken down into specialized development areas. Commonly, ECU's will be assigned and development by a specialized suppliers as shown in figure 4. The OEM will analyze the given product mission and final requirement specification (FRS) to investigate to keep a business activity in-house and resolve which development task will be outsourced or designed in-house. The decision is base upon some fundamental questions:

- "*Does the activity require assets that are highly specialized? Will those assets be idle or obsolete if that activity is no longer performed? (If yes, then disaggregate.)"* [11, p.45]
- *"How frequently is the activity performed within a period or business cycle? Is it infrequent or sporadic? (If yes then disaggregate.)"* [11, p.45]
- *"How complex is the activity? Is it simple and routine? Is it stable over time with few changes? (If yes, then disaggregate.)"* [11, p.45]
- *"Is it hard to define good performance? (If yes, then aggregate.)"* [11, p.45]
- *"Is it tightly coupled with other activities or assets in the business? Would separating it increase complexity and cause problems of coordination? (If yes, then aggregate.)"* [11, p.45].
- If required by system design rules or system design necessities: Is Collaborative product design and Engineering knowledge management feasible or interest of the OEM? [15] If yes, then disaggregate.
- If required by system design rules or system design necessities: Is distributed engineering knowledge management feasible or interest of the supplier or external business unit? [15] If yes, then disaggregate

The above set of question is only a rough summary of checkups to be made before deciding to bring in an external supplier. For example automotive products require over their lifetime to be maintained. Thus a general IT or Automotive Projects life cycles should consist of an evolution or maintenance phase (see fig.1), also known as the sustainable development phase. The maintenance phase is a very important phase and requires that the legal agreement between OEM and supplier/business-unit incorporates this project life cycle extension.

3.3. Organizational Evolution: Mastering Evolutionary and Revolutionary Change

Mastering Evolutionary and Revolutionary Change *"demands that mangers periodically destroy that has been created in order to reconstruct a new organization better suited for the next means to reconstruct a new organization better suited for the next wave of completion or technology"*. [17, p.24] Figure 3 shows business units model which collections of assets, which have to be adapted to meet the goal set by the specification (FRS) or product mission. Organizational Evolution is only possible if the changing demands of market, feed into the specification are used also to check whether the organizational assets are ready to fulfill the task. Revolutionary Changes or especially short-term must-have-demands of the market require the same treatment; if possible this may be improved by forecasting via market surveys or cooperation with trendsetter.

3.4. Supplier Management

Supplier management is a key process to facilitate business outsourcing activities and is one of the drawbacks of Multi-Company-Models due to additional project cost, management tasks and risks as follows:

- *"Supplier and contract management"* [9, p.3]
- *"Coordination and interface management, especially with fragmented / distributed processes"* [12, p.3]. Figure 4 shows how an example of distributed ECU's and sub task such as the navigation map which require such a process.
- *"Project management and process control"* [9, p.3]
- *"Training, knowledge management, communication"* [9, p.3]
- Support and Training to understand und utilize the OEM infrastructure, process landscape and tools.
- Quality management

In fact all the asset (see figure 3) of the external supplier organization must be controlled, trained and adapted to meet the project environment and requirements. There are several risks to be aware of while dealing with external business partners:

- Extern Skills are paid from the very beginning, must be also educated, but after the project finalization the asset knowledge belong to the business partners.
- Significant know-how is lost, the dependency on external companies increases, and the increased control and coordination effort is often unrelated to the hoped-for cost reduction. [22].
- The employee's contract, as well as the contract between the OEM and the business partners might allow only restricted cooperation or teamwork, which might prevent or slow down development processes [19-22].
- *Risk is the major drawback with business process outsourcing. Outsourcing of an information system, for example, can cause security risks both from a communication and from a privacy perspective. For example, security of North American or European company data is more difficult to maintain when accessed or controlled in other countries.* [18, see *"Threats"*]
- *From a knowledge perspective, a changing attitude in employees, underestimation of running costs and the major risk of losing independence, outsourcing leads to a different relationship between an organization and its contractor.* [18, see *"Threats"*]

4. Conclusion

The discussion of this paper considers the automotive market cost pressure of products, which does not allow the software/hardware configuration (e.g. memory size) to be ready for more than the predefined set of functions. The same cost restrictions is valid for the development team, with respect to human resources during initial development and possible maintenance of the product, which should be part of the product-mission in order to secure the success of the product beyond the SOP. In addition, offers opportunities such as: 1) Customer satisfaction, 2) Lessons learned findings due to customer feedbacks which could be used for a planned evolution and maintenance of a product. This paper offers as a set of activities (see figure 5), structuring a solution as follows:

- The 1st step is to extend the "Project life cycle of Automotive Projects" with the additional "Maintenance and Evolution Phase" as shown in Figure 1. In fact the "Evolution" phase is a commonly used OEM process and called "model-upgrade". The time used for a model-upgrade depends on the OEM, but is usually 6 up to 12 month. The reduced timeline of the evolution phase compared with the initial development time (Concept-Development + Concept Validation + Preparation for Production) required a more advanced and sufficient development process and organizational evolution.
- Appropriate Organizational-Evolution is possible if the changing demands of market are feed into the specification and is then also used to check whether the organizational assets are ready to fulfill the task. The paper suggest that, a feasibility study or impact analysis (driven via the CM-Processes) should include the investigation of the capabilities shown in figure 3 of the responsible business unit to deliver the RfC. The

Automotive Product-Evolution is always present; therefore Business unit's capabilities and company resources should be check as described anytime if an RfC occurs; starting from the very beginning of the product life cycle until the actual start of End-Of-Production, thus the Organizational-Evolution needs be started directly with the start of CM1 (see figure 1).

- In addition, the product evolution or any change request should also trigger the assessment of the management processes (i.e. change management), organization structure, team collaboration methodologies [8] (see figure 1 "Traditional/Adaptive development models") and required capabilities/resources of the business unit's und partners (see figure 3). Dealing with "Multi Company Models" as shown in figure 4

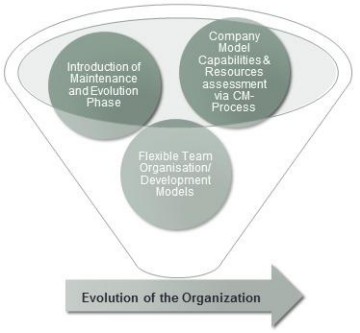


Figure 5. Organization Evolution activities

The analysis of dealing with "Multi Company Models" (see "Analysis of Multi Company Models") summaries the characteristics of such a business partner constructions, but it is most significant to understand that the organizational setup is only valid for the current product mission that means any change of specification carries the potential to change the organizational model; on a smaller scale for example the decision to keep a business activity in-house and or to be outsourced.

The organization structure or business partner collaboration methodologies have different boundaries or restrictions depending on the contract between the OEM and business partner (supplier, sub-supplier, internal or external team partners). The collaboration rules must be clearly defined and understood by management (and all stakeholders) and result to a clear understanding of outsourcing and their corresponding risks, threats and merits to derive a clear scope of possible partnership models. However, organizational evolution with respect to the need of reducing development time to fit into the "Maintenance and Evolution Phase" (see figure 1) is with external business partner rather restricted due to the employer and workers' council regulation. A nowadays popular means to reduce development time is described by agile mythologies [8], which would be use full for the Evolution-Phase, but requires being part of the collaboration rules to void an illegitimate temporary employment [26].

4.1. Open discussion, next research steps:

- Business continuity management (BCM) model setup [18]
- Software change-management or systematic RfC impact measurement methods [9, *Best Practices in Software Measurement*]

References

(1) K. Rouibaha and K. R. Caskey 2003 Change management in concurrent engineering from a parameter perspective, Computers in Industry, Volume 50, pages 15-34
(2) ITIL3 Service Transition 2007 ISBN 978 0 11 331048 7
(3) ITIL® glossary and abbreviations English 2011 http://www.itilofficialsite.com/InternationalActivities/ITILGlossaries_2.aspx, ITIL, www.itil-officialsite.com/InternationalActivities/TranslatedGlossaries.aspx, ITIL®, Last access, 12.03.2014
(4) Sommerville I 2004 Software Engineering, 6th Edition, Addison-Wesley, p 644-650

(5) G. Kotonya, I. Sommerville 1998 Requirements Engineering - Processes and Techniques, First Edition, Wiley Publishing, Chichester, UK, ISBN 0 471 97208 8, page 6
(6) Stephan Volker, Gabriela Prostean, Andrei Hutanu 2016 Research of Automotive Change Management and Supportive Risk Management. Soft Computing Application, Volume 357, pages 1097-1108, Springer.
(7) Stephan Volker, Gabriela Prostean 2016 Research of Automotive Change Management and Combined Risk-management Models, SIM 2015 / The Procedia - Social and Behavioral Sciences, 13th International Symposium in Management, Volume 221, 7 June 2016, Pages 395–404
(8) G Prostean, S Volker and A Hutanu, International Conference on Applied Sciences (ICAS2016), Impact of agile methodologies on team capacity in automotive radio-navigation projects
(9) Christof Ebert, Reiner Dumke, Manfred Bundschu, Andreas Schmietendorf, Best Practices in Software Measurement, ISBN 3-540-20867-4 Springer, 2005, page. 22
(10) Jie-Cherng Chen, Sun-Jen Huang, An empirical analysis of the impact of software development problem factors on software maintainability, The Journal of Systems and Software 82 (2009) 981–992
(11) ITIL Service Strategy, 2007, ISBN 978 0 11 331045 6
(12) Christof Ebert 2007 Optimizing Supplier Management in Global Software Engineering, IEEE Computer Society Press, pp. 177-185.
(13) https://www.telemotive.de/fileadmin/user_upload/content/Grafiken/Engineering/Bussysteme.png, last access 06.06.2016
(14) G Prostean, S Volker and A Hutanu, International Conference on Applied Sciences (ICAS2016), Change management methodologies trained for automotive infotainment projects
(15)Yuh-Jen Chen, Yuh-Min Chen, Hui-Chuan Chu, Enabling collaborative product design through distributed engineering knowledge management, Computers in Industry 59 (2008) 395–409, 18 December 2007, www.elsevier.com/locate/compind
(16) Pär Carlshamre and Björn Regnell, Requirements Lifecycle Management and Release Planning in Market-Driven Requirements Engineering Processes, Accepted for publication at REP2000 (International Workshop on the Requirements Engineering Process: Innovative Techniques, Models, and Tools to support the RE Process, 6th-8th of September 2000, Greenwich UK, preceeding the DEXA Conference) © IEEE CS Press
(17) Ambidextrous organizations: Managing evolutionary and revolutionary change Tushman, Michael L; O Reilly, Charles A III California Management Review; Summer 1996; 38, 4; ABI/INFORM Global pg. 8
(18) Business process outsourcing, https://en.wikipedia.org/wiki/Business_process_outsourcing, last access 11-07-2017
(19) Misclassification of employees as independent contractors <https://en.wikipedia.org/wiki/Misclassification_of_employees_as_independent_contractors> [last access 11-07-2017]
(20) Temporary work, https://en.wikipedia.org/wiki/Temporary_work, [last access 11-07-2017]
(21) Werkvertrag (Deutschland), https://de.wikipedia.org/wiki/Werkvertrag_(Deutschland) [last access 12-07-2017
(22) Was sind Werkverträge, https://www.fokus-werkvertraege.de/werkvertraege/[last access 12-07-2017
(23) Primary Source: Automotive OEM. The OEM Terminology, graphics and data are altered; the original OEM Company-Name, milestone expressions and schedules are not used due to strict arrangements of confidentiality. The examples are based on personal experience.
(24) Business continuity planning, https://en.wikipedia.org/wiki/Business_continuity_planning, [last access 13-07-2017
(25) Connected car: https://en.wikipedia.org/wiki/Connected_car [last access 04-09-2017
(26) Arbeitnehmerüberlassung, “Verdeckte Arbeitnehmerüberlassung”, https://de.wikipedia.org/wiki/Arbeitnehmer%C3%BCberlassung, [last access 06-09-2017