Developing e-learning solutions in the automotive industry

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Abstract

In the rapid developing market of automotive industry, cutting-edge technologies are being introduced. One such example is the AUTOSAR standard. Companies are investing a large amount of finances for the training of their employees into the intricacies of such technologies. In order to face such an increase of the training costs, automotive corporation have started lately switching their approach to e-Learning systems. This paper presents an e-Learning approach developed in the automotive industry in order to address the demands of teaching AUTOSAR standard. The developed e-Learning project is called Academy. In order to develop the e-Learning solution we focused on the Software Development part of automotive industry. Therefore we had to gather the ideas from different trainers, come with a common approach and use specific techniques so that the trainee should get a real feeling of the material. It is presented the design, implementation and evaluation of this e-Learning solution, but more than that faced issues and learned lessons. Developing this solution has offered different insights into how to approach such a task which are useful for the further expansion of the project, but also for future researchers who might encounter such a challenge of developing e-Learning solutions for the automotive industry. These are all grouped in a set of guidelines related to following a model of implementation, getting track of participants, user interaction with the AUTOSAR standard, test and production development and so on.

Keywords: Automobile industry, education, e-learning, guidelines.

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1. Introduction

Every large organization strives to implement different approaches in order to have their employees trained in specific technologies needed for accomplishing their complex projects. Such an example is that of the automotive industry. Different consortiums have been formed in order to come up with state-of-the-art research in a field which is of great importance for society. In order to train their employees in cutting-edge technologies, such corporations are facing challenges in terms of time and costs. First of all, senior employees are developing trainings for fellow colleagues; they can come from different cultures and vary in number as was presented by (Jagga, 2013). Secondly, the training generally is presented in more than one Research & Development locations. Dealing with global corporations, this reaches a global scale and for example, a specialized training developed in Europe can be later on presented in Asia or America. During the past years, a plethora of technologies have emerged in the automotive industry, requiring continual updates of the personnel, therefore leading to an exponentially increase in the number of trainers and business trips.

One such technology is that of the AUTomotive Open System ARchitecture (AUTOSAR) standard which was developed as a partnership in order to offer an open industry standard for the automotive software architecture between suppliers and manufacturers, states (Heinecke, 2006). (Fennel, 2006) defines the scope of this standard as formed by a set of specifications which are describing the components of the software architecture, but also by the definition of the interfaces between them. One of the large companies that is using the AUTOSAR standard is Continental Automotive AG, providing solutions for the major automobile manufacturers of the world.

In order to come up with an alternative to the increase number of trainings in the AUTOSAR projects, one of the solutions that is lately taken into consideration is that of introducing targeted e-Learning trainings. Such solutions are available to different learners which are spread in different parts of the world. Alternatively, the content can be downloaded and consulted offline and also different assessment modules can be implemented in the e-Learning training.

2. Literature review

From the automotive industry perspective (Ma & Li, 2008) stress the importance of education time, with a special accent on the time needed to learn (trainee time). They propose a complete model that satisfies four needs: the one for the client-side courseware, the courseware developing environment, the Resource Management System (RMS) for monitoring the students as well as an educational document store. (Xin, 2009) also stresses the importance of education time in the industry, presenting e-learning as the most suitable solution. The system architecture proposed by (Xin, 2009) is distinguishable by the blend of customized e-learning and the knowledge gathering aspect from both trainer and trainee with the end-goal of building an extensive knowledge management system. Bringing together both the education and industrial experience, (Lukac, 2015) stresses the difference between the industrial and educational-specific approaches, mainly the time aspect and provides several guidelines to merging the teaching and industrial processes.

Based on a cognitive and behavioural point of view, the paper of (Karaali, Gumussoy, & Calisir, 2011), states that "anxiety and facilitating conditions are found to be the antecedents of perceived ease of use, and social influence is found to be the antecedent of perceived usefulness". However, (Ivanova, Grosseck, & Holotescu, 2012) acknowledge only the personal learning networks as significant for the decision to use a web-learning system. A counter-argument can be made, that Karaali's paper took into account only blue collar workers, but this brings the multi-modal, multi-user teaching methods into focus. (Jagga, 2013) presents the variety of presentation methods that needs to be employed to satisfy the different learning needs of the participants

(Weichhart & Stary, 2009) also emphasizes a modular approach, but the accent is shifted towards a collaborative on-the-spot Agile automotive learning system, that also serves as a knowledge repository. The e-learning architecture is seamlessly integrated with the Agile process, thanks to a modular approach, however, no real learning management system is implemented.

There are many papers in this fields, however most fall at the different ends: either presenting an engineering/pedagogical approach or an industrial one. For example, (Einwächter, Tourou, & Sourkounis, 2014) presents a practical engineering pedagogical approach, by using virtual experiments to allow users the discovery and fixation of theoretical concepts. (Travassos, Machado, & Maciel, 2013) inclines towards an engineering approach by using an extensive 3D virtual reality system orientated towards active learning. (Gordienko, Stirenko, Gatsenko, & Bekenov, 2015) discuss the possibility of interweaving various parts of the "digital ecosystem" while stressing the multimodal, interactive flexible selection approach. However, in all three cases, no learning or knowledge management system are implemented. On the other hand, the active learning part, is beautifully executed and followed.

In conclusion, e-learning is highly customizable and architectures and implementations differ greatly depending on the trainees, developers and trainers. However, when dealing with industrial implementations, certain characteristics, like time and multimodal learning are frequently mentioned, in a mostly passive learning environment.

3. Material and method

In choosing a schema to train automotive industry employees there are a couple of options available. Management needs to take into account both the trainer and trainee from a time and cost perspective. There are two main currents: the traditional (classroom) method which can be seen as a centralized option and the e-learning method which is a distributed option.

Table 1. Time and cost constraints in traditional and e-Learning environments

		Traditional		E-learning	
Activities	POV	Trainer develop training OR learn and present training	Trainee spend 8 hours every 3 months to learn	Trainer study previous trainings + develop training + present training + collaboratively evaluate + maintenance + interface between levels	Trainee spend as much time as needed until lessons are learned
Time	Education	16 hours or more; multiple-sites; recurring	8 hours; Recurring	200 hours or more; one location; one-time	varies; one-time
	Industry	less development time (senior-level) less business trip time	less development time (junior-level)	can be externalized	varies (expected to be lower)
Cost	Education	medium; recurring	medium; recurring	high; one-time	very low; recurring
	Industry	high: senior-level tasks delayed + occasional business trip	medium: low-level tasks delayed 1 day every 3 months	medium to high; one-time	very low; recurring

Using traditional (classroom style) methods implies that there is a trainer who is well versed in the subject and also has pedagogical skills that allow him/ her to develop a suitable training, training which, in turn, is distributed to selected locations, in which other senior-level or at least advanced-level individuals learn it and then pass it on to junior-level employees in a day or more of concentrated learning. In the particular case presented here, this also might imply that the location trainer might be "borrowed" in other locations that do not have personnel with enough expertise, therefore creating from a management point of view a loss of time spent developing senior level-activities and / or training local employees as well as business trip-related costs.

The e-learning methods imply a lot of work on the trainer side, who has to have significant knowledge in both the training field and the pedagogical field. Moreover, a strong research and comparison of previous trainings is necessary, which coupled with the strong inter-personal skills needed to mediate between the management's many requirements and trainees' capabilities and drive create a very specific and specialized skill portrait for the trainer. However, once the trainer completes the preparation, only minor maintenance is then needed, thus making the whole process a one-time occurrence. From the trainee side the e-learning is definitely a better experience, as it allows self-pacing, informal interfacing with others at the same-level and even, occasionally, mentorship chances that boost one's moral and drive in learning the subject.

The available options are summarized in the table above, pointing as an economic and time-conscious solution the e-learning option. In the following paragraphs the practical experience in developing an automotive specific e-learning solution is presented.

3.1. Proposed solution

The solution, which is nowadays part of an actual ongoing automotive project, is to transfer the existing materials, knowledge and also software tools in an e-Learning environment. In this way, the AUTOSAR training can be offered at a lower cost, but to a larger community around the world. In order to achieve this task different steps were taken into consideration.

Step 1: Search for different tools that can be used in order to achieve the above goal

A survey has been developed and two possible tools came up in the end. One of them is TT Knowledge Force (TTKF) and the other is Adobe Presenter. The first one has already been purchased and used in the company mainly in the logistic and accounting departments, so it came up to be the one that was going to be used.

Step 2: Defining a process in order to develop the online training material

In order to develop the e-Learning solution a process has been defined which is presented in Figure 1.

Figure 1. The process to develop a TTKF online training material (TT Knowledge Force, 2015)

First of all, together with those trainers who have already offered the training in the traditional approach, the content was defined and structured. One major task was that of adding additional information and explanation to the ones already existing. One faced problems in this point was that in

the traditional point of view, the training was developed by a senior trainer, then passed to other advanced individuals who were supposed to be presenting the material in their own locations. So there was the need to organize a two-level content addition and structuring, which involved both the creators of the trainings, but also those individuals that were presenting the material and had a closer interaction with the trainees.

Next, giving the fact that the future user was supposed to interact with a software tool, an interaction part was defined in the form of recording the software tool functioning. This recording is offering the facility to directly interact with all the options (like developing and testing configurations) of the software environment that the future AUTOSAR specialist will use. In order to consistently realize the recording and software interaction, the senior trainers offered their support.

The TTKF tool automatically provides an automatically-generated documentation for the developed content. Such a documentation needs to be edited and sometimes improved with explanations.

And finally, the content was sent to be reviewed by the trainers, modifications were performed based on the review and then officially submitted. A real problem on this level was that of differentiating between working with TTKF on a test server and on a production server. The official content is supposed to appear on a production server, hence the necessity to develop it here and not on the testing one.

Step 3: Evaluation of the e-Learning solution

After the content was submitted, the e-Learning solution was sent locally to all the developers and testers to evaluate and come-up with improvement ideas and findings. During this step suggestions for adding a separate module on how the e-Learning train is being used, but also adding quizzes and assessments were received. In order to add new features to the existing content, Step 2 and Step 3 are to be applied. One of the main problems that appeared on this part was the fact that TTKF is not a Learning Management System. So basically no tracking of participants could be realized. In order to overcome this, the tool provider suggested to use other existing options which were already available in the company.

4. Results

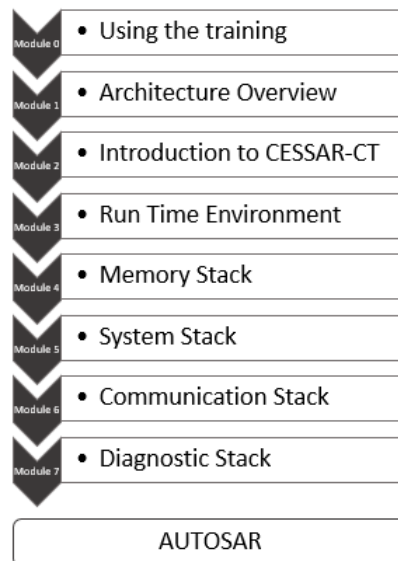The architecture of the obtained solution is presented in Figure 2.

Figure 2. Architecture of the e-Learning solution

It can be noticed that the main AUTOSAR modules were developed in in TTKF, but also an additional module on using the e-Learning content has been added. This solution is practically offering to each trainee the means to understand and apply the intricacies of AUTOSAR standard to different projects. Giving the fact that is an e-Learning system, issues such as time and cost were overcome. Participants can be from different locations around the world and the trainer does not have to move long distances for a certain Research & Development center. From the trainee point of view, he / she can spend as much time as needed until lessons are learned and also different quizzes and assessments are available both during the concept presentation and at the end of each module.

4.1. Proposed guidelines

Based on the literature review and the acquired hands-on experience developing the present solution, a set of guidelines for developing e-Learning content for automotive industry is presented below:

1. Establish with great accuracy the requirements of the e-Learning project. Develop different use-cases so that you might figure out which are the features that should be developed.

2. Based on the requirements, conduct an extensive study of the possible software solutions which can be taken into consideration to develop the e-Learning training. There are different tools for online training material which are not Learning Management Systems so different desired features are not present, such as participants' tracking or feedback. Therefore is very important to establish from the beginning extensive requirements.

   a. Communicate with the management on what can the particular tool offer; clearly state the limitations. Even if there is a tool already available in the company, it is not necessary to use it for a certain task where is not completely applicable.

   b. If, from different reasons, you have to develop an e-Learning project with a solution that does not offer the tracking of participants, then search for alternatives for this particular task.

3. Follow a development model of the e-Learning solution.

4. After selecting a tool that meets desire requirements, organize a training for that tool.

   a. From this training, try to clarify the e-Learning content development IT location (e.g.: a test server or production server). If the development is on a test server, then find out when the content should be moved to the production server where will be the official version of the e-Learning project.

   b. If you plan to embed different media files in the chosen tool, understand the intricacies of this operation (software limitations, bandwidth, etc.)

   c. Find out if you can obtain a local build of the project. Sometimes it is useful to upload it on a location from where it can be downloaded.

   d. Pay attention if there is a way of automatically generating a project documentation.

5. Understand the differences between quizzes and assessments. Quizzes might be applied without a clear mark, just to understand some important topics, while the assessments usually take place at the end of a module.

6. Establish iterations with clear feedback.

7. Define a time when to implement in the e-Learning solution the provided feedback.

8. Establish if knowledge gathering towards a knowledge management system is needed.

5. Conclusions and future work

This paper presents an e-Learning architecture implementation in an industrial setting coming from a university background. The time required to develop this solution implied was over 250 hours, however this was the equivalent of approximately 12 traditional trainings (from the trainers' perspective) or of just 6 traditional trainings (from the managerial perspective that considers training as time missed from senior-level activities), which, for an international company means that from the start, the solution is highly sought after. The difficulties in implementation leaned more towards the requirements definition for the e-learning environment. Due to the global characteristics of the corporation, managers from very different sites, backgrounds and cultures had different expectations, therefore leading to a lengthy process mediation. As the solution is part of an ongoing project, new iterations are expected, but based on the lessons learned the new development will take even less time.

As future work we plan to organize an extensive campaign of evaluation of the existent system in addition to the locally existent one and also based on this, different other features are planned to be added.

Acknowledgements

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