Managing CALIPSOneo Project: Learning from Trenches

Alberto Salido López *alberto.salido@iwt2.org*
Web Engineering and Early Testing Group, University of Seville
Seville, Spain

Julián Alberto García García *julian.garcia@iwt2.org*
Web Engineering and Early Testing Group, University of Seville
Seville, Spain

María José Escalona Cuaresma *mj.escalona@us.es*
Web Engineering and Early Testing Group, University of Seville
Seville, Spain

Abstract

The model-driven engineering paradigm is a paradigm that combines the power of concepts and its relations, using abstracts models in order to offer suitable mechanisms for software development. In fact, software engineering community has applied MDE in different contexts of software engineering, getting suitable results. Despite these mechanisms, both global coordination and effective management of big software projects are not always easy task. Lack in communication lines, configuration plan execution and risky management are activities that have been executed by development teams in order to assure the quality of results, an essential point for a project to succeed. The paper's aim is to present an approach based on the NDT methodology in order to solve these problems pulsar and how it has been applied in a real project called CALIPSOneo.
Keywords: Model-Driven Engineering, Software Process Management, Product Lifecycle Management.

1. Introduction

Model-Driven Engineering (MDE) [18] paradigm is being used by the research community in the last years, obtaining suitable results during for software development. For this, MDE is focused on concepts and how these concepts evolved (using abstracts models) in the life cycle of a product.

Over the last decade, software engineering community has applied MDE in different contexts of software engineering, getting suitable results. For instances, it was used in the context of the web engineering, in methodologies such as UWE (UML Web Enginnering) [23] or WebML (Web Model-Languages) [24]; in the context of software testing, with approaches such as [25, 26]; in software product lines, such as [27]; or even in more specific contexts like software architecture, with the approach WebSA [28]. These researches have produced suitable results that could be considered an inspiration source for the industrial community. However, very few experiences were reported from the enterprise [29]. In addition, the situation is not different big software project in which a global effective management is necessary.

Global coordination and effective management of a big software project are not always easy tasks. The lack in lines of communication [30], configuration plan execution and risk management are activities that development teams carry out in order to assure quality of results.

The paper's aim is to present a quality and effective solution based on tools and framed into methodological framework. To illustrate the feasibility of our approach, it has been applied to a real aeronautical project called CALIPSOneo. Airbus EADS CASA[1] developed this project in collaboration with the University of Seville (Spain), Polytechnic University of Madrid (Spain) and T-Systems[2]. The project presented some relevant characteristics like a heterogeneous and distributed team (from Madrid, Seville and Barcelona; Spain), a new technology for the team and, even, for final users that required the application of concrete and effective techniques for its right management.

This paper evaluates in practice the application of classical techniques, after being improved with four main factors:

1) The application of the MDE Paradigm, as a key factor for software development and quality management, using the NDT (Navigational Development Techniques) [4] methodology and its tool case, NDT-Suite [7][14]. NDT has been successfully applied in a large number of real projects. Nevertheless, it was adapted and applied in a new context, the aeronautical one, which entails modifying the methodology and its management policies.
2) The use of effective tools for project management.
3) The use of effective management documentation based on ECM (Enterprise Content Management) solutions, such as Alfresco [1]. According to AIIM (Association for Information and Image Management) [22], ECM consists of strategies, methods and systems used to capture, manage, store, preserve, and deliver content and documents related to organizational processes. ECM systems and strategies facilitate the management of an organization's unstructured information, wherever that information exists.
4) The use of collaborative communication tools, such as WebEX [2], in order to improve communications among all stakeholders. Quality communication allows effectively conveying and receiving messages to and from others.

The paper is structured as follows: Section 2 offers a global vision of NDT. Section 3 introduces the problem which has been our catalyst to carry out this research (for this purpose, we have relied on a real project: CALIPSOneo). Section 4 and Section 5 describe our proposal and then the results obtained after being applied to CALIPSOneo project, respectively. Finally, Section 6 states some conclusions and future work.

2. NDT: Navigational Development Techniques

Navigational Development Technique (NDT) [4] is a Model-Driven Web methodology that was initially defined to deal with Web development requirements. NDT starts with a goal-oriented phase of requirements and establishes a set of transformations to generate analysis models. NDT has evolved in the last years and offers a complete support for the whole life cycle. Nowadays, it covers viability study, requirements treatment, analysis, design, construction or implementation as well as maintenance and test phases, such as software development phases. Additionally, it supports a set of processes to bear out project management and quality assurance and sustain different life cycles, for instance, sequential, iterative and agile processes. As an advantage, NDT can be applied in the enterprise environment. Today, many companies in Spain work with NDT and the associated tools for software development. This is possible due to the fact that NDT is completely supported by a set of free tools, grouped in NDT-Suite [7] [14]. This suite enables the definition and use of every process and task supported by NDT and offers relevant resources for quality assurance, management and metrics with the aim of developing software projects. NDT is based on the Model-Driven paradigm. It selects a set of metamodels for each development phase (requirements, analysis, design, implementation, construction, test and maintenance) in order

[1] Airbus Defence and Space website: http://www.airbusmilitary.com/
[2] T-Systems' website: http://www.t-systems.es/

to support each artefact defined in the methodology. All concepts in every phase of NDT are metamodeled and formally related to other concepts by means of associations and/or OCL [12] constraints. Besides, NDT proposes a set of QVT Transformations (Query/View/Transformation) [16] among each metamodel in every phase, that may enable to get one phase results from the previous one. Nevertheless, transferring this idea to the enterprise environment is not possible. Companies do not actually use metamodels, transformations and other elements, thus technology seems too abstract for them.

After assessing different possibilities, some UML-profiles were developed for each NDT metamodel. These UML-profiles were defined in a UML-based tool named Enterprise Architect [19]. Then, the first tool for NDT-Suite, NDT-Profile, was developed. The remaining NDT-Suite tools are based on this profile and offer a range of different uses when applying NDT, as it is described below:

1. **NDT-Profile** is a specific profile for NDT, developed by means of Enterprise Architect. This tool offers the chance of having all the artefacts defining NDT easy and quickly as they are integrated within the tool called Enterprise Architect.
2. **NDT-Driver [**8] is the key tool to execute transformations among NDT models. It implements a set of automated procedures that enables to perform all MDE transformations among the different models of NDT previously described. The data source to use this tool is a project developed with NDT-Profile.
3. **NDT-Quality [**9] is a tool that automates most of the methodological review of a project developed with NDT-Profile. It checks the quality of using NDT methodology in each phase of a software life cycle and the quality of traceability of MDE rules of NDT.
4. **NDT-Prototype** is a tool designed to automatically generate a set of XHTML prototypes, from the Navigation models described in the Analysis phase, of a project developed with NDT-Profile.
5. **NDT-Glossary [**6] consists in implementing an automated procedure that generates the first instance of the glossary of terms of a project developed by means of NDT-Profile tool. This tool is useful for the validation of requirements captured during the Requirements phase of the project.

In addition, NDT-Suite has more tools: NDT-Report, NDT-Checker or NDT-Counter. You can see the purpose of these tools on IWT2 website.

As it can be concluded, NDT has become a complete approach offering high support for software project development by exploiting the power of the Model-Driven paradigm.
In the last years, NDT has evolved again and now, in order to offer a suitable and a global solution for the real application of NDT, a global framework named NDTQ-Framework [17] was developed. NDTQ-Framework comprises a set of processes involving development processes, management processes, quality processes, testing processes and security processes. This environment is based on different reference models like CMMi (Capability Maturity Model Integration) [3] and ITIL (Information Technology Infrastructure Library) [13] and its application in real projects are certificated under different standards like ISO 27001 [11], ISO 9001:2008 [10], UNE EN 16602 and ISO 14000. This paper does not aim to present NDTQ-Framework in detail, but you can download more information from IWT2 website[3].

3. Motivating scenario: CALIPSOneo project

In the last ten years, NDT is being used in a high number of real projects developed by different companies, either public or private. As a result, they have provided us with an important feedback. One of these projects is CALIPSOneo (advanCed Aeronautical soLutIons using Plm proceSses & tOols) [5], which has been developed in Airbus EADS CASA by multiple and different teams. From the experience of this project we know that requirements are difficult to conciliate in projects involving multiple teams. This paper proposes improving the NDT methodology to solve these problems during requirements conciliation.

[3] IWT2's website: http://www.iwt2.org/

CALIPSOneo is an ambitious project based on PLM (Product Lifecycle Management) [31]. Its main objective is the design of a new PLM methodology to conform to a PLM collaborative design and the required development of the software that satisfies that concept. This methodology allows defining, simulating, optimizing and validating the aeronautical assembly processes in a 3D virtual environment before these processes are implemented in a real shop floor. CALIPSOneo is subdivided into three individual subprojects, in order to effectively manage the work needed to complete it. They are: MARS (autoMAted shop-flooR documentation updating System), PROTEUS (PROcess sTructure gEneration and Use) and ELARA (gEneraLization to assembly oriented authoring Augmented ReAlity). Figure 1 shows one schema of the whole system with the MARS, ELARA and PROTEUS projects represented.

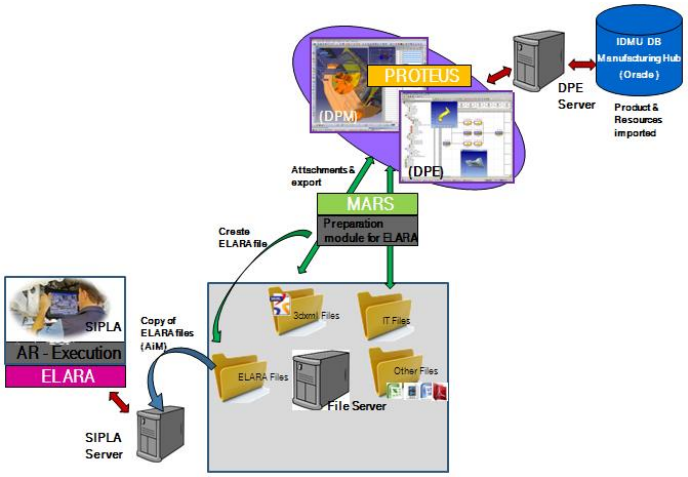

Fig. 1. General scheme of the CALIPSOneo project

These subprojects are totally different not only about their content or functionality, but the team evolved within. However, subprojects must be coordinated and correctly integrated because they have common actors who demand ordinary functionality.

PROTEUS was performed by a team which expertise is focused on the 'real PLM context', i.e., how an engineer will work with the environment to develop a manufacturing task. Engineers will use PROTEUS to define assembly operations, even using a 2D interface (DELMIA PROCESS ENGINEER or DPE) or 3D interface (DELMIA PROCESS MANAGER or DPM). On this assembly tasks, the engineer must take into account the products and resources used to perform the process. The process will be analyzed to optimize their times, costs, and use of resources. For this purpose, PROTEUS is responsible for the Product, Process and Resources structure definition as well as the interrelations to create an iDMU (industrial Digital Mock Up) [20].

MARS is in charge of exploiting iDMU using the manufacturing process defined by the engineer using PROTEUS and uses it to obtain automatically the documentation (Work Instruction) needed at shop floor for the airplane assembly. A Work Instruction is a 2D or 3D document with the detailed instructions for the shop floor worker, being easily for him to perform the assembly task. The connection between PROTEUS and MARS was extremely high, sharing the same environment (DELMIA PROCESS MANAGER) and depending for the process made in PROTEUS by the engineer.

Finally, the central objective ELARA must achieve is to develop a system which should provide workers in assembling tasks, with augmented reality technology, still valid on any airframe, using either the 3D information included in iDMU or the information coming from MARS. The final result will be an industrial prototype to be used in the assembly process of FanCowl product in A320Neo program.

The three projects described are very different, and the teams that work in them are also very different. Not only for the task have they had to perform, but also the distance between teams an important fact to take into account. It is harder to work, depending of teams from

others states or countries. Taking into account that the three projects depends one on the other (ELARA depends of MARS and MARS depends of PROTEUS), they were performed in parallel, that means, the specification of the projects have to be very well described according to ensure the proper communications of them.

About the technologies used, on PROTEUS, the main tools used were database storage to communicate the information across both interfaces, the 2D (DPE) and the 3D (DPM). MARS handles scripting and programming in .NET[4] to export the information from DPM to Microsoft Word documents. Also MARS uses the information from DPM to generate 3D work instructions, rendered in 3DViaStudio Player. ELARA uses Augmented Reality and mobile technologies. As we can see, every project has a different expertise, so the teams evolved in the project were also very different, making this project, CALIPSOneo, a multidisciplinary project, increasing the effort needed to perform a proper communication between teams.

4. Approach

Our approach can be addressed by means of three different areas: (i) project planning and meetings; (ii) project management; and (iii) deliverables storage and working space. This section describes each of these areas and their interactions with the developed project.

Firstly, in large or small projects in which there are different teams working remotely and collaboratively, both **project planning and meetings** must be flexible and with the least possible cost, but weekly meetings are also necessary to control the project progress.

This monitoring is a complex task when there are geographical locations constraints. For example, in our project (CALIPSOneo) team leaders were in different Spanish cities (T-Systems from Barcelona, Polytechnic University of Madrid from Madrid and, University of Seville and Airbus EADS CASA from Seville). Our proposal includes using professional collaborative tools for meeting. For example, in our project we used WebEx [2] which provides a web environment for teleconferences, being able to share documents and desktops as well as controlling other computers remotely. Chiefly, these meetings were carried out through AT&T [32], but they were quickly replaced due to the integrated calls WebEx included. WebEx allows connecting to conferences using the computer audio and microphone, which makes this tool very useful.

Secondly, in our proposal we have had into account the **project management** in order to achieve both global coordination and effective management of big software projects. we propose to use web tools (such as Redmine [33]) to project management. In addition, these tools should provide integration mechanisms to facilitate communication with methodological project environment in order to link the methodological process tasks with project planning.

The next area handled the **project's deliverables storage and working space** for the development team. One of the main requirements of the project was the use of a common repository for documents storage. These documents encompassed minutes of the meetings, external documentation (like users manuals or references), final deliverables for the project and 'in work' documents. For this purpose, we propose to use Alfresco [1] to manage final documentation and Subversion to manage 'in work' documentation. Additionally, Alfresco includes a version control for all the documents, which was very useful for managing the versions of the deliverables generated throughout the project.

In relation to deliverables storage and 'in-work' documents, we recommend the use of Subversion because it can be set up in every computer, providing a local copy of all 'in-work' documents for each participant in the project. That will avoid that many people use the same document. Once the file is finished, it cannot be modified and it is stored into Alfresco by using versioning systems.

[4] http://www.microsoft.com/net

5. Results

The projects were successful in general. However, it is known that always that a new methodology or a new workflow is introduced, the learning curve is very high and the susceptibility to use it is not the same for every participant in the project. Below we will analyze each of the three main pillars described in Section 4 (project planning and meetings, deliverables storage and working space, and task management), pointing out each advantage and disadvantage as well as the proposed solution for future work.

With regard to meetings, the selected tool, WebEx, was a great option, providing a common dashboard and the possibility of sharing content or control other computers remotely. One of the main advantages of this tool was the ability to use an external phone for calling or the computer audio system. This characteristic was very useful for holding a meeting via laptop, without depending on a physical phone.

In relation to project planning, at first, each project leader of CALIPSOneo used a different management tool. Some team leaders used Microsoft Project for scheduling. This tool was used about the entire project, but not using the whole performance of the same; it was only useful for Gantt Diagram visualization. Other team leaders use Microsoft Excel or xMind [34] for the same propose. The main goal was showing the progress achieved during the week in the meeting, so the tool ceased to be important. This variety of tools became confusing, since a different tool was used in each project meeting concerning CALIPSOneo project. Moreover, these types of tools are not collaborative, i.e., new versions were stored every week into the documental repository, Alfresco. As a result, a huge amount of versions for project planning was produced, being complicated to access them.

However, this working method proved unworkable in collaborative environments. Consequently and following our proposal, we used Redmine which provides integration mechanisms. Using this functionality, we were able to establish MDE mechanisms to transform different models of NDT (which were specified in NDT-Profile) in tasks which could be planned and managed within Redmine.

This is one of the core-points on which we are working for future projects. The use of a web-based tool; based on Redmine, being easy to show the project's goals and task on time using a Gantt Diagram.

Next point is the use of the documental repository, Alfresco. Alfresco was the most used tool during the project storing even final documents, or project's deliverables, and 'in work' documents. The main advantage of Alfresco was also its greatest fail. This tool provides the user an easy way to upload files, which quickly became a box without order in which everyone stored its files without any criteria. Alfresco provides a version control for each file it stores, making easy to rollback to any previous version. One of the main errors was to upload the same file in different versions, by adding at the end of the file the deliverable version, increasing the number of files for each deliverable and making difficult to find the last one. Another problem related to Alfresco was that many people used the same file. This posed a lack of coordination due to the physical separation of the people involved in the project. As a result, each company working with a file duplicated it, by adding its name. After a period previously defined, the file was combined, merging the work run by all the enterprises in a unique file. This work is performed by one person and it usually takes a few days to finish it, therefore it is possible to make mistakes.

Once all the pros and cons achieved during the project have been reviewed, we summary the working methodology used for multidisciplinary projects, involving worldwide working teams.

Regarding meetings, we have used Redmine in addition to WebEx, since this tool can show the progress of the project quickly. This reduces the wasted time in meetings. In addition, Redmine provides a Wiki and Forum section, which makes easier share knowledge and solve problems between people in different countries in an agile manner. Despite e-mail can be an alternative, its lack of agility and response times are not viable in a collaborative context. Redmine can manage all the tasks to carry out together with the project's schedule.

NDT methodology, used to ensure the quality of the product developed, was extremely difficult to apply due to the amount of local copies of the same file. Enterprise Architect file, which is the base tool for NDT-Methodology was created for each subproject mentioned in section 3. Each company worked with a local copy, and after a scheduled period of time, the responsible member integrated all the local copies into a file, called master file. Once the master file was created, the working teams kept on working until the next scheduled integration period.

This work plan will be replaced by Subversion, integrated into Enterprise Architect. This will enhance collaborative work and avoid scheduled periods for merging changes.

This proposal will be implemented on the next projects so as to solve problems found on CALIPSOneo and stress positive features.

6. Conclusions and Future Work

This paper has presented a practical evaluation of a set of good practices and management policies. These policies are based on three main pillars represented by: Model-Driven paradigm with NDT and NDT-Suite approach; documental management policies, with an effective use of Alfresco; and collaborative tools, in order to assure the right development of the project.

The paper has shown how the right application of these good practices and policies constitutes an effective mechanism for quality assurance. However, it is very important to stick out that the right tools support has been essential and very critical for the successful result of our project. In CALIPSOneo, despite each member of the team knew the rules, the suitable tools helped each member to follow his/her work. There were daily and weekly controls and corrective activities were executed very frequently. The cost that these controls can suppose in a software project, if no-suitable tools are offered, is higher in many situations.

CALIPSOneo has laid the foundations for a set of works developed in liaison with Airbus Defense and Space that currently involves two new projects, EOLO (factoriEs Of the future. industrial develOpment) [20] and Geolia (first Generation of aErospace iDMU cOncept impLemention And deployment) [21]. Management policies used in CALIPSOneo are extended in these new projects, which are being carried out at present with new members. Other tools, such as Redmine, have been added in this new period according to our policies so as to improve some aspects that were not well supported in previous projects, such as workload or daily planning.

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