Virtual Cost Engineering Studio (V-CES): a framework for Cost Engineering services

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Abstract

Cost has become a business driver. V-CES is a European Project aiming to develop and deploy a set of services to the Cost Engineering Community: Training, a Cost Engineering Virtual Community, a Cost Estimating Tool, and a Cost Engineering Database. The access to such services will be done via Internet and a Web browser. This implies the possibility for the cost professionals of exercising a just-in time training, estimating and consulting related to their work. The use of these services implies interactions of the kind client-server and peer-to-peer, and their implementation demands the use of different software technologies, being the main ones: Virtual Learning Environment (VLE), database, multi-agent toolkit, and reasoning engine. This paper presents the technological definition of the framework to be used for the over all development and implementation.

Keywords

Cost Engineering, Cost Estimating, Cost Database, Virtual Training, Intelligent systems

1 Introduction

Cost is perhaps the most influential factor in the outcome of a product or service within many of today's industries. Predicting cost of a product is a challenging task that requires a lot of experience and data [Rush and Roy, 2001]. In this sense, it has been observed that there is a limited training in cost engineering practices, and that there is a lack of availability of cost related data in many industrial sectors. V-CES is a European founded project which aims to address these issues. The consortium is made up of five partners: IZET Innovationszentrum Itzehoe, Cranfield University, Centro Ricerche FIAT, PRICE Systems, and DAS GmbH.

The purpose of this paper is to present a general description of the technical aspects involved in the V-CES project. This objective demands the analysis of the different disciplines that come together in the project, mainly related to: cost engineering, e-training, databases, industrial sectors, company profiles, potential users, and network framework as a deployment context. In the following sections, each of these elements is explained.

2 Scope of Cost Engineering in V-CES

The relevance of cost and the need to predict it applying engineering principles and techniques is widely recognized by industry and academia. In essence, cost engineering is a discipline with a wide scope of concern, from [Roy 2003]: "*cost engineering is concerned with cost estimation, cost control, business planning and management science, including problems of project management, planning, scheduling, profitability analysis of engineering projects and processes*". In particular, V-CES focuses on 'cost estimating', which is the first stage and function of cost engineering, with the objective of approximate, in an independent, objective, accurate and reliable way, the true cost of producing a product.

When considering the elaboration of a cost estimate, there are different methodologies that can be used for its development. As it is presented by Roy [Roy 2003], "*where and when*"

each of the possible techniques can be used, depends on which stage of the product life cycle the estimate is carried out. In V-CES, three main cost estimating methodologies are considered: *bottom-up*, *analogy based*, and *parametric.* Among the three methodologies, the parametric one is based on the identification and mathematical formulation of relationships between cost and product parameters, known as cost estimating relationships. This approach demands the access to historical data and assumes that the relationship will continue in a similar way in the future. The bottom-up methodology, also known as *detailed*, demands access to detailed cost data, and the allocation of the cost elements, mainly: labour, material, and equipment. The analogy-based or *case-based* requires to identify the similarities and differences of items, identify a reusable case, and adapt it if necessary.

3 Industrial sectors and company profiles

The industrial sectors addressed in the project are: automotive, aerospace and semi-conductor equipment manufacturers. These sectors are quite distinctive, mainly because the kind of product they produce. The project for a new airplane, car, or equipment, is quite different in terms of complexity, duration, risk and cost. The particular characteristics of these products, and the profile and practices of the companies play an important role when considering the cost engineering practices used. From the experience gained in the aerospace and automotive sectors [Roy et. al. 2001], [Rush and Roy 2001], a few general conclusions can be outlined: each company has its own way of implementing cost engineering techniques and processes, cost engineering (CE) depends heavily in the availability of reliable cost data, CE as any other engineering activity demands a strong commitment of man-effort and skilled cost engineers, and more collaboration between the Original Equipment Manufacturers (OEM) and the suppliers is needed.

One profile of company to be specially addressed is the '*Small and Medium size Enterprise (SME)*'. The fact that SMEs need more attention to improve their technological level is widely recognized by the European Commission, which promotes specific actions for this kind of companies. When referring to e-training or e-learning, the picture is quite similar. As it is presented by [Attwell 2003], and quoting from the report:

- Many SMEs lack a basic learning culture or organised training plans and infrastructure.
- There is little support from managers for introducing e-learning, and there is no organised and planned action to take up e-learning.

Considering these issues, it can be concluded that: there is a need to train employees in CE practices, to provide a collaborative space for CE practices both in a forum environment and in a peer-to-peer basis, and the solution has to address the specific situation in the SMEs.

4 E-training and tutoring

The reason for using the term '*training*' in V-CES derives from the definition of the term itself: "*the process of learning the skills needed for a particular job or activity*", *training* in V-CES is: "*the process of gaining the knowledge and the ability needed for developing cost estimates*". In line with the definitions provided in (http://www.jisc.ac.uk/), e-training can be defined as: "*training facilitated and supported through the use of information and communication technology (ICT)*". A similar term is Computer-based training (CBT), which is together with: On-the-job training (OJT), games and simulations, and lectures and discussions, one of the four basic classes of training [Blanchard & Thacker 2004].

Based on the idea of: '*available at any time and anywhere an Internet connection exits*'; V-CES will allow implementing a kind of Just-in Time Training (JITT) in Cost Engineering. The idea of JITT [Lewis and Romiszowski 1996] relays on research that shows that a

relevant part of the information learnt on a training course is forgotten by the time the trainee needs it, so the solution to this would be to take the training course as much close as possible to the time when the knowledge and skills are needed, Just-In Time.

A Virtual Learning Environment (VLE) will be used for the development and deployment of JITT in Cost Engineering. It is relevant to mention the lack of availability of on-line material in Cost Engineering. Just a very few sources have been identified: AACE International, Al Dell'Isola (www.vecourse.com), and West Virginia University.

4.1 Virtual Learning/Training Environment

Currently there are different terms being used to describe online learning systems: Virtual Learning Environment (VLE), Learning Management System (LMS), Managed Learning Environment (MLE), Learning Content Management Systems (LCMS), and Content Management System (CMS). In [Schoolnet 2003] there is a definition of all these terms, and the kind of services that they may include. For the purpose of V-CES, the selected VLE system is Moodle. However, as any VLE system with a certain level of maturity, it lacks of any kind of '*intelligent tutoring or mentoring*', element that is of special relevance to V-CES.

4.2 Intelligent tutoring

Intelligent tutoring demands the integration of different technologies, which usually go beyond the scope of the current VLE or CBT systems. It requires the use of Artificial Intelligence techniques, for instance: multi-agent systems and inference engines [Garro & Palopoli 2003]. The tutoring solution is also affected by the adoption of a pedagogical approach, in this respect, and according to [Mayes & de Freitas 2004] three learning perspectives can be considered: associative view, cognitive view, and situative view, with each of them emphasising different aspects of the learning process. V-CES will utilise existing research in this area to develop the training environment and the associated tutoring.

5 Cost database

There is some research identifying the level of data required for cost estimating [Roy et. al., 2003]. But in addition to it, the definition of the data itself, e.g. the definition of the logical or conceptual level through the creation of a 'conceptual schema' or 'data model', is one of the kernels of this part of the project. In particular, this part leads to the use of standards, and the definition of taxonomies, related to equipment, material and labour. The second fundamental aspect is the cost data collection to populate the database.

6 V-CES network framework and enabling technologies

The network framework in which the outcomes will be deployed demands a hybrid client-server and peer-to-peer interactions. Because of the kind of services V-CES aims to provide, and the kind of interactions expected, there is a set of technologies that need to be considered: SOAP, XML, HTML, Web protocols, and Java development frameworks like J2EE.

Special attention has to be given to the 'intelligent tutoring system', and in particular to 'multi-agent systems' as a possible platform for its development. Distributed agent systems demand the use of a '*middleware toolkit*'. JADE [Bellifemine et al. 2003] is the toolkit selected in the project. It allows the development of applications based on a hybrid peer-to-peer communication architecture, and it has been already used for e-Learning research purposes [Garro & Palopoli 2003]. Additionally, because of the 'intelligent tutoring system', a declarative rule engine compatible with Java has been selected. Based on this context and on the functional requirements identified in the project [V-CES 2005] the Figure 1 presents a high level description of the technology to be used.

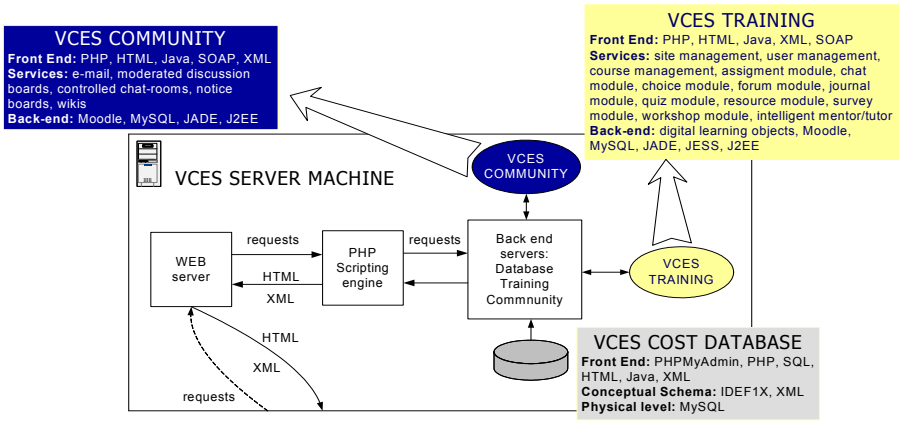

Figure 1: V-CES technical description

7 Concluding Remarks

The paper presents a framework to develop an on-line training, database, and cost estimating tool. It is observed that the current level of technology allows developing an interactive intelligent CE training environment. The development of a CE database is challenging and depends heavily in the definition of a standardized data model and in the availability of cost data. The service is initially developed for aerospace, automotive and semiconductor equipment manufacturing industries, but it can be relevant to other sectors using parametric, detailed or analogy based cost estimating techniques.

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