Improving Cost Estimation Capabilities in System Organizations
- Transparent Cost Estimation Modeling with CoBRA® -

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Abstract

Accurate planning of activities for the development of software or software-intensive systems is a crucial project management task. Especially in the system engineering context (such as the space domain), the development of multi-diciplinary components (e.g., software, mechanics, optics, etc.) is nowadays usually performed in a distributed and parallel way. From the management perspective, this requires synchronized and coordinated activities that can be planned in advance on a level of sufficient accuracy. As a consequence, accurate estimation techniques are needed in order to deliver software or systems on time and within budget.

Good estimation capabilities of an organization are essential factors for its competitiveness and ability to develop high-quality software or systems. Over- and underestimates of expected costs or efforts have negative effects on the process performance and on the organization's reputation and ability to be competitive in the market. Being able to make realistic bids for external contracts, assessing cost risks or having the capability to compare costs with similar projects helps to adjust project plans and to perform proper resource allocations.

Estimating in the software engineering context is considered to be more challenging than in other domains (such as production engineering). This results from the specific characteristics of software. Software development efforts, for instance, are typically context-dependent, include creative activities, and usually lack a sufficient amount of data for applying purely statistical methods. Many practical examples show budget overruns and projects taking longer than expected. Estimates are often done based only on subjective judgement and in a hurry. In addition, the planning and development context often does not support estimation activities (or even prevents them): Immature processes, insufficient requirements specifications, and the lack of explicit experience from past projects are typical factors that aggravate estimations. Improving an organization's estimation capabilities and modifying contexts so that more accurate estimations are possible are substantial tasks for high-maturity organizations.

A lot of methods and tool sets for supporting estimation are available. The methods can be classified according to [Briand and Wieczorek, 2002] into model-based methods and non-model based methods depending on the involvement of a model (see Fig. 1). Non-model based methods can be applied in new application domains (such as wireless Internet service development) where no explicit experience from the past is available. Methods based on expert judgement without any usage of past data or data from comparable projects or domains are typical non-model based methods. These methods are often applied in low maturity organizations. Model-based methods require a modeling approach that relates influence factors and cost estimates. They require explicit quantitative experience from past projects for the development of the model. Model-based estimation methods can be generic or specific. Generic model-based methods are supposed to be generally applicable (e.g., COCOMO [Boehm 1981], SLIM [Putnam, 1978]). Specific model-based methods can be tailored to specific contexts (such as embedded space software) and are only valid for these contexts. Specific model-based methods can be further subdivided into hybrid and data-driven

methods. Data-driven methods use analysis techniques on past project data in order to build cost estimates. Examples are CART (classification and regression trees) [Breiman et al., 1984] or OSR® (optimized set reduction) [Briand et al., 1993]. Hybrid methods involve both expert opinion and data driven modeling. Examples are CoBRA® (cost estimation, benchmarking, and risk assessment) [Briand et al., 1998] and analogy-based methods [Delany et al., 1998].

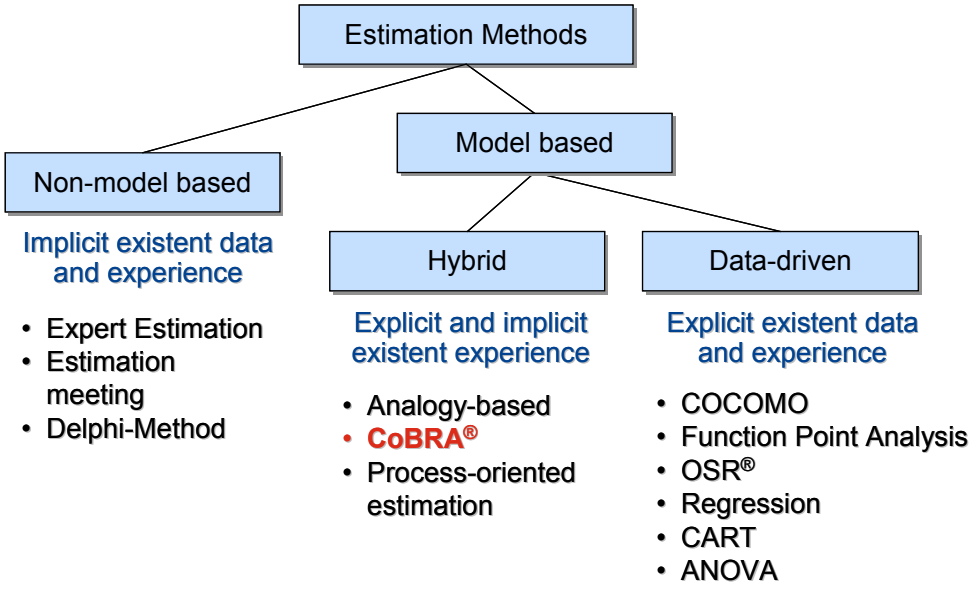

Figure 1. Cost estimation methods

Nowadays, many organizations are starting to introduce and use measurement as well as quantitative and empirical approaches in software development contexts. For example, organizations approaching CMMI level 3 and 4 or the respective SPICE levels are focusing a lot on measurement and data. As a consequence, they have the possibility to improve their estimation capabilities. Usually, there is still a lack of complete project data that could be appropriately used by a data-driven method. The involvement of experts is still necessary. For such organizations, we recommend to progressively introduce hybrid estimation techniques such as CoBRA® that require only little data from past projects and involve expert judgement in a systematic way.

CoBRA® is a hybrid cost estimation method that has been developed at the Fraunhofer Institute for Experimental Software Engineering in Kaiserslautern, Germany. In contrast to many black box methods for deriving a cost estimate, CoBRA® allows for building transparent cost estimation models by using organization-specific data and utilizing expert knowledge. Benefits of CoBRA® can be seen with respect to a) its accuracy (the estimation error in CoBRA® applications in the past was between 9%-15%), b) minimal requirements (only about 10 already completed projects are needed and data can be elicited from past projects), c) its comprehensiveness (it utilizes knowledge present in employees' heads; it supports the documention of explicit past experience), d) its reusability (the model can be reused across similar projects and maintained over time).

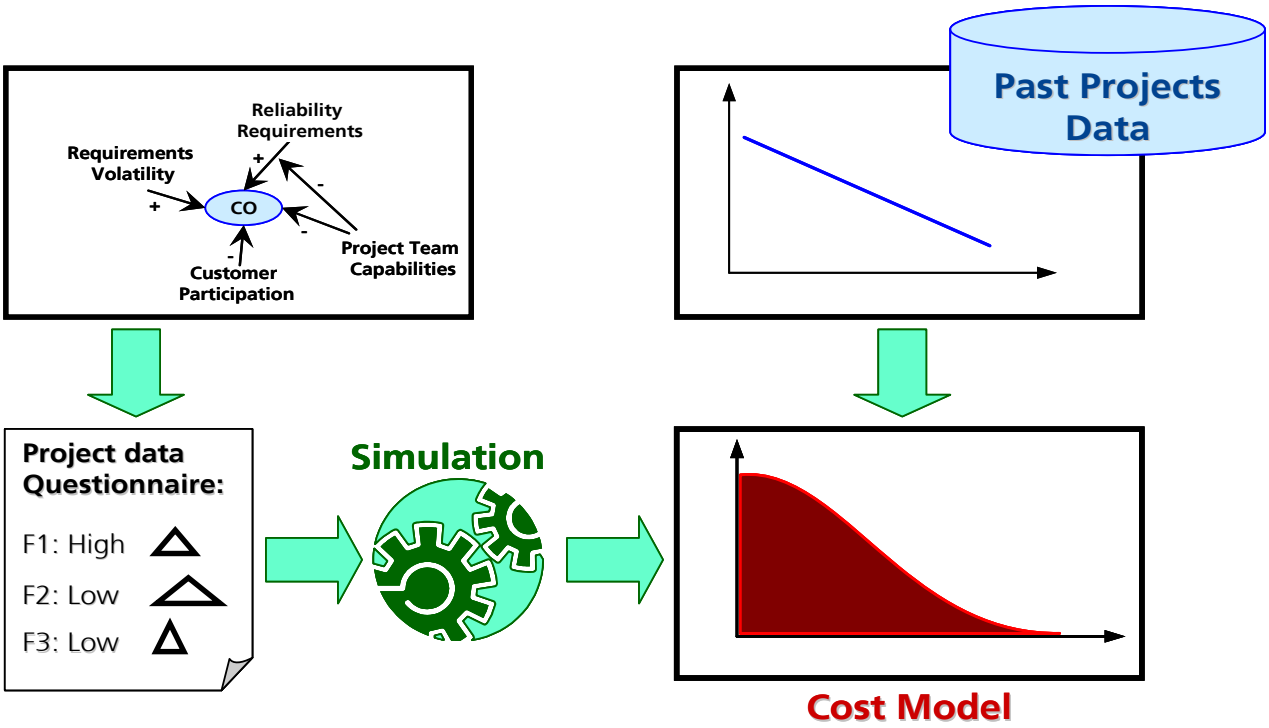

Figure 2. CoBRA® method overview

The presentation describes the importance of cost estimation for advanced software and system development organizations and shows how estimation capabilities can be improved over time. The presentation focuses on companies that base their improvement efforts on measurement and quantitative approaches (such as TAME [Basili and Rombach, 1988]) and gives an introduction to the CoBRA® method. In addition, evaluation results and experiences from industry applications (e.g., via Fraunhofer IESE) will be given.

Biography

Dr. Münch is Department Head for Quality and Process Engineering at the Fraunhofer Institute for Experimental Software Engineering (IESE), Kaiserslautern. From November 2001 to December 2003, Dr. Münch was an executive board member of the temporary research institute SFB 501 "Development of Large Systems with Generic Methods" funded by the German Research Foundation (DFG). Dr. Münch's research interests in software engineering include: (1) modeling and measurement of software processes and resulting products, (2) software quality assurance and control, (3) technology evaluation through experimental means and simulation, (4) generic methods for the development of large systems, (5) technology transfer methods. He has been teaching and training in both university and industry environments, and also has significant R&D project management experience. Dr. Münch is a member of IEEE, the IEEE Computer Society, the German Computer Society (GI), a member of the program committee of various software engineering conferences, and has published more than 40 papers in books, journals, and conferences.

Fraunhofer IESE's Activities in Japan

The Fraunhofer Institute for Experimental Software Engineering IESE offers methodological instruments to design software development processes in a plannable manner and to be able to bring software-based products to market more efficiently by consistently applying engineering-style principles. The work foci of software engineering, project- and quality management as well as experience management and human resource development concentrate on typical problem areas such as quality defects, time and budget

overruns, or lack of sustainability of the established methods in practice. The Japanese Information-technology Promotion Agency (IPA) has signed a long-term cooperation agreement for collaborative research with Fraunhofer IESE. The main purpose is to support the Japanese Software Engineering Center (SEC). The long-term relationships of Fraunhofer IESE to Japanese universities such as the renowed universities in Osaka and Nara in the area of software engineering led to intensive collaboration in terms of contract research with companies such as Ricoh Co., Ltd. and Fujitsu. Recently, a service agreement with the Japan Aerospace Exploration Agency (JAXA) was signed.

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