Chapter 5
A Bayesian Approach to Project Control

Franco Caron
Politecnico di Milano, Italy

ABSTRACT

The capability to elaborate a reliable estimate at completion for a project since the early stage of project execution is the prerequisite in order to provide an effective control of the project. The non-repetitive and uncertain nature of projects and the involvement of multiple stakeholders raise the need to exploit all the available knowledge sources in order to provide a reliable forecast. Therefore, drawing on a set of case studies, this paper proposes a Bayesian approach to support the elaboration of the estimate at completion in those industrial fields where projects are denoted by uncertainty and complexity. The Bayesian approach allows to integrate experts' opinions, data records from past projects and data related to the current performance of the ongoing project. Data from past projects are selected through a similarity analysis. The proposed approach shows a higher accuracy in comparison with the basic formulas typical of the Earned Value Management (EVM) methodology.

INTRODUCTION

Forecasting is a critical activity in project management: relying upon sound estimates to complete, the project manager can steer the ongoing project in order to meet specific time and cost objectives (Dvir & Lechler, 2004). Moreover, foresight is needed to avoid constantly being forced to manage emergencies, since emergency is often a lack of foresight. Without anticipation there can be no rationale in making a decision and we'll have to be at least adaptable to changing circumstances.

Planning and forecasting are strictly intertwined both in the early stage when the project baseline must be determined and throughout the entire project life cycle when project objectives have to be pursued (Hogarth & Makridakis, 1981). In the project control process the role of the Estimate To Complete (ETC) is critical, since the information drawn from the ETC, in comparison with the project baseline, may highlight the need for and the type of corrective action that may change the project plan. In fact,

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ETC is the base for any effective corrective action. This approach to project control corresponds to a *feed-forward* type control loop (Anbari, 2003; Christensen, 1996), since analysis of the future informs present-day decisions.

From a recent survey (Merrow, 2011), analyzing the data of more than 300 global mega-projects, it appeared that in 2010 65% of the industrial projects with a minimum budget of 1 billion US dollars did not succeed in meeting the objectives of cost, duration and quality. This means that the forecasting accuracy is a critical problem for the project control process and, in particular, the methodologies commonly applied for forecasting purposes require an improvement.

To explain this kind of poor performance of the forecasting process, some considerations must be developed about the knowledge sources feeding the process, the forecasting techniques to be applied and the mitigating measures taken in order to avoid possible biases affecting the forecasting process.

As shown in Figure 1, at a given time of the project duration, i.e. the time now (TN), a certain amount of the work will be already completed (Work Completed, WC), while the rest of the work will be ahead, corresponding to the Work Remaining (WR). The cost and time performance related to the Work Completed will be known, while a forecast will have to be developed for the WR.

It should be noted that both the *accuracy of the forecast about WR* and the *impact of the corrective actions* that may be implemented based on the forecast depend on the progress of the project at the time now. The effectiveness of the corrective actions is greater in the early stages of the project execution and progressively diminishes while progress increases: in fact, as progress increases, the degrees of freedom available to steer the project tend to reduce progressively. On the other hand, the capability to forecast the project final duration and the final cost follows an opposite trend. In fact, at an early time in the execution phase, the knowledge available to the decision maker is scant and rapidly evolving; therefore, the capability to provide a *reliable forecast* is jeopardized, particularly if the forecast is only based upon the analysis of the performance of the ongoing project until the time now.

Drawing on a set of case studies (Caron et al., 2013a; Caron et al. 2013b), this paper will propose a Bayesian approach to determine the estimate to complete for a project. The paper has a twofold objective:

Figure 1. Estimation at completion at time now (internal view)