



## **Chapter XVI**

# **Integrating the Balanced Scorecard and Software Measurement Frameworks**

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## **INTRODUCTION**

This chapter describes the integration of the Capability Maturity Model (CMM) and ISO-9126 software measurement frameworks with the National Aeronautics and Space Administration Independent Verification and Validation Facility (NASA IV&V). Balanced Scorecard IV&V is a unique aspect of software development practice as it provides a service of independent and objective lifecycle evaluation of the software product and processes used for development. To accomplish this rigorous task a sophisticated measurement program is desirable. This chapter describes the application and integration of strategic measurement (BSC) with organizational measurement (CMM) and product measurement (ISO-9126). The CMM is a measurement model of ordinal ranking of an organization's software process variability and repeatability. As an organization's process becomes more mature it may traverse the scale from a level one to a level five organization. The CMM provides a basis for collecting accurate and timely measures of process performance. The international standard ISO/IEC-9126 focuses on information technology and software product evaluation through measurement of software quality characteristics. The development of a core set of metrics for implementing the Balanced Scorecard is the most difficult aspect of the approach. Developing metrics that create the necessary linkages of the operational directives with the strategic mission prove to be fundamentally difficult as it is typical to view organizational performance in terms of outcomes or results. The metrics must address performance drivers or the measures that provide feedback concerning day to day progress.

The Balanced Scorecard Institute has identified 12 criteria to guide the development of metrics (1999):

1. Leading indicators: forecast future trends inside and outside the agency
2. Objective and unbiased
3. Normalized - so they can be benchmarked against other agencies
4. Statistically reliable - small margin of error
5. Unobtrusive - not disruptive of work or trust

6. Inexpensive to collect - small sample sizes adequate
7. Balanced - qualitative/quantitative, multiple perspectives
8. Appropriate - measurements of the right things
9. Quantifiable - for ease of aggregation, calculation and comparison
10. Efficient - can draw many conclusions out of data set
11. Comprehensive - show all the significant features of agency's status
12. Discriminating - small changes are meaningful.

This list represents the ideal of a set of metrics, in practice it is very difficult to develop metrics that achieve all twelve criteria. For that reason the metrics that are chosen should be evaluated as to their degree of conformance to the ideal and evaluated for inclusion or exclusion to the organizational metrics program.

This chapter follows this organization. Background is provided that describes independent verification and validation. A high level overview of the tasks and activities conducted by IV&V are described. The BSC architecture is described as if being constructed in conjunction with BSC leading and lagging measures. The customer themes are described and their corresponding measures stated. The integration of the ISO-9126 process measures and the CMM infrastructure or learning and growth measures are discussed. The chapter concludes with a summary of lessons learned.

## BACKGROUND

IV&V is a set of technical and managerial activities performed by someone other than the developer of a system to improve the safety, quality and reliability of that system and to assure that the delivered product satisfies the user's operational needs. These activities can provide the benefits of defect avoidance and defect detection at early stages of the lifecycle. A primary contribution of IV&V is the early discovery of defects, thus preventing their propagation into the later stages of the development process where they are far more costly to correct. Independent Verification and Validation is characterized by the notion that the activities associated with IV&V are performed by a group other than the developers of the system. The degree to which the IV&V group is independent from the developers is assessed across three areas technical independence, managerial independence and financial independence. In this section we describe the meaning of independence and the key activities of V&V.

### Technical Independence

Technical independence is characterized by the notion that the IV&V group has a perspective of the system that is unbiased by the developers of the system [9]. Thus, it follows that the IV&V personnel should be people not involved in the development process. This promotes the need for the IV&V group to formulate its own understanding of the problem itself and how the system is solving that problem. With respect to software tools, ideally the IV&V group should develop its own set of testing tools separately from the developers testing tools. In cases where development of a separate version of tools would be too expensive, the IV&V group may share some of the developer's tools. If the IV&V group is to share any developer's the IV&V group must perform qualification tests of said tools. These tests are to ensure that there are no errors in the tools themselves that may mask errors in the software.

### Managerial Independence

To achieve managerial independence, the responsibility for the IV&V effort must rest

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