



Systemic analysis of the critical dimensions of project management that impact test and evaluation program outcomes

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Abstract

It is generally believed that adopting standard organizational project management (PM) practices enhances the capability of organizations to achieve program success and customer satisfaction. We asked what specific dimensions of PM practices have been most helpful to project and program managers of Test and Evaluation (T&E). This paper focuses on T&E PM within the Federal Aviation Administration, an agency of the US government. The objective was to identify the critical dimensions of PM that contribute to successful T&E execution and determine how these critical dimensions could be unified with technical processes to achieve customer satisfaction. By combining the expressive abilities of the Boardman Soft Systems Methodology with a case study approach, we identified a set of critical dimensions and created a conceptual model that unifies PM practices with T&E processes. We concluded with a set of critical project management practices that have impact for a T&E organization.

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1. Introduction

The process of managing test and evaluation (T&E) programs is a highly challenging endeavor which has been comprehensively documented in the literature over the past three decades (Burnstein et al., 1996; Nagano, 2008; Voetsch and Whitehead, 2008). The objective of T&E is to identify critical defects early in the development process. The failure to do so adversely affects operational effectiveness and suitability. The presence of critical defects in deployed systems and at initial deployment has continued to be a major problem affecting cost, schedule, and

customer satisfaction (Adolph et al., 2008; Castellano, 2007; Riemer, 2007; Voetsch and Whitehead, 2008).

In particular, widely varying results from the operational test (OT) phase of system acquisition programs at the US Federal Aviation Administration (FAA) have led to a decades long program to improve overall performance and repeatability of results in the FAA test organization (Felder, 2013). We asked whether it might be possible to identify a specific set of project management practices that were well matched to the FAA's test organization and that could be applied to improve the performance of test and evaluation projects in general.

Lack of institutionalized best practices and inadequate coordination of appropriate stakeholders have been found to increase the risk of T&E programs failing to achieve performance and quality objectives (Adolph et al., 2008; Bell, 2008; Castellano, 2006, 2007; FAA, 2006c; Riemer, 2007). It has been suggested that a new framework unifying project management practices with T&E

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technical processes would address the associated institutionalized dissatisfaction with the test and deployment process (Burnstein et al., 1996; Castellano, 2006, 2007; Riemer, 2007; Voetsch and Whitehead, 2008).

Branch (1976) proposed a systems approach to managing T&E to address the role of conflict and parochialism resulting from lack of alignment between T&E and the management functions. He identified some elements of project management that could enhance T&E resource management. It has also been recognized that the lack of integration between project management and systems engineering is a major source of unproductive tension (Conforto et al., 2013), since T&E is widely regarded as a phase in systems engineering, and we can expect that these conclusions are also specifically applicable to T&E.

Branch (1976) hypothesized that adopting a systems approach to executing T&E would facilitate early V&V activities so as to improve the early identification of defects and minimize the cost of fixing defects late in the systems development process. This paper offers a methodology for developing new T&E project management frameworks by identifying the critical dimensions of project management practices that can be integrated with T&E execution processes. The critical dimensions are elements of project management that have been found in practice by test program managers to add value to their ability to successfully deliver quality results. Although the framework described in this paper is specific to our chosen test and evaluation organization, the technique is easily applied elsewhere.

Project Management as defined by PMI (2013) is the application of knowledge, skills, tools, and techniques to project activities to meet the stakeholder's project requirements. Most test projects within our case study environment have two or more parts integrated into a large functional system. In this context we use the term "program" to refer to the centralized coordinated application of project management principles and practices to achieve the program's strategic objectives and benefits. Processes are typically managed at the program level. Accordingly, we use the term project management exclusively to describe best practices at the T&E project level.

We used a multiple case study methodology (Eisenhardt, 1989; Yin, 2014) to determine the critical dimensions of project management that positively impact T&E execution outcomes within the FAA. We used the Boardman Soft Systems Methodology (BSSM) as described in Boardman and Sauser (2013) to elicit information from interviewees within the multiple case study process. Individual and cross-case analyses were performed using pattern-matching logic. The results provided the basis for building an integrated T&E project management model. The model was designed as a framework to enhance the ability of T&E organizations to execute test programs through institutionalized processes.

The resulting project management best practices have direct utility in improving the performance of T&E within the case study subject domain, namely, the FAA T&E organization. These results can also be extended, with successively lower applicability, to other US Government test and evaluation domains, as well as to test and evaluation outside the government arena. The methodology used has wide applicability.

1.1. Background: test and evaluation within the US government and the FAA

The FAA's role in providing the safest air transportation system in the world is accomplished by multiple subunits including the T&E organization, which is the system under observation (SuO) for this research. Typically, the role of T&E in systems development is performed by a separate organizational unit that serves the function of providing verification and validation (V&V) support to the program offices (PO) throughout the systems acquisition process (Adolph et al., 2008; FAA, 2006a).

The FAA procures many different types of system, and these are all tested under the same policies. For the purposes of this study, we have limited our scope to a set of relatively large, software intensive command and control systems used in support of air traffic control operations, which the agency identifies as "automation" projects. The projects we chose were deployed between 1995 and 2004. We chose completed projects to allow proper time for reflection by the participants in our data collection process.

The salient role of the FAA T&E organization is in developmental and operational test responsibilities. The organization provides test and evaluation support for acquisition decision making at various stages of the lifecycle process (mission analysis, investment analysis, solution implementation, and in-service management). The FAA's lifecycle process, which is similar to that of the Department of Defense (DOD, 2004) is structured with a T&E organization that is charged with the responsibility for systems V&V in support of program offices (FAA, 2006a). Its roles, depending upon the phase in the lifecycle process, are achieved through testing, simulation, or demonstrations to determine whether requirements are achievable and verifiable.

In the early stages of acquisition, the organization performs requirement verification, design demonstration, and simulation (FAA, 2006a). Later in the process, the organization conducts tests to verify requirements and determine whether the system meets user needs. Finally, it provides an independent system assessment report to the program office, which is responsible for making the deployment decision.

1.2. Background: the role of project management in test and evaluation

One of the primary objectives of a T&E organization is to help the program office ensure that quality systems are delivered to the customer by conducting effective verification and validation (Adolph et al., 2008; Burnstein et al., 1996; INCOSE, 2004; Nagano, 2008; Voetsch and Whitehead, 2008). It is considered a feedback loop to the system lifecycle process and a means of achieving cost effectiveness to maximize return on investment. The T&E organization provides independent evaluation of systems for the program office (Kasser, 2000) to support the delivery of quality systems that meet operational needs without compromising schedule and cost performance goals (Cooke-Davies, 2002; De-Wit, 1988). However, achieving this objective has been a critical issue that continues to defy

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