Understanding the Roots of Process Performance Failure

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The U.S. Department of Defense (DoD) acquisition community seems to be perpetually searching for the answer to the question, "Why isn't program performance significantly improved given all of our investments in process improvement?" Over the past several years, the Office of the Secretary of Defense, in partnership with each of the services, sponsored a performance-oriented assessment effort called the Tri-Service Assessment Initiative that has provided some answers to this question. The initiative was based on a flexible, expert assessment methodology consistently applied to a wide scope of DoD programs. The assessment process allowed for valid cross-program quantification and evaluation of recurring or systemic program issues across the assessed program base. As this systemic analysis capability matured, both DoD program and enterprise managers brought critical analysis questions to the systemic analysis team. One of the most significant of these centered on what the impact of process improvement investments was across the DoD infrastructure. In this article, we will provide a summary of how the results of the DoD cross-program systemic analysis help provide insight into the causes of the recurring process shortfalls in DoD programs.

Despite an increased process focus within Department of Defense (DoD) programs over the past 15 years, there is an increasing gap between program cost, schedule, and technical performance requirements and the capability of program teams to realize them. In our recent analysis of the results of 23 DoD program assessments, *process performance shortfalls* were identified as a primary factor underlying the inability of the programs to meet their acquisition objectives and technical performance requirements. Our analysis showed that nine out of every 10 DoD programs that were assessed exhibited process performance shortfalls – program teams were unable to specify, design, integrate, or execute development processes that met the specific needs of their unique programs. Given the increase in technical and management complexity of future DoD programs, and the trend toward massive systems of systems, our analysis projects that this process-related performance gap will widen.

Performance Assessment and Analysis

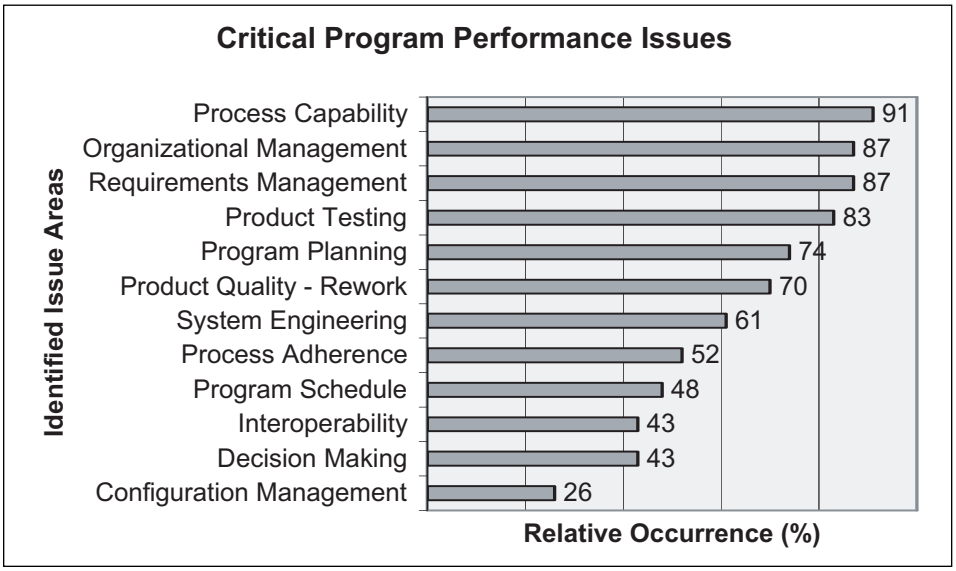
Over the past four years, the Tri-Service Assessment Initiative performed more than 50 major DoD program assessments that spanned the range of acquisition category levels, platforms, domains, and services. This was one of the largest independent assessment programs ever conducted that employed a well-defined and consistent technical approach[1].

The assessment approach encouraged the assessment teams to *drill down* to the causative issues across a very wide scope of acquisition, programmatic, and technical areas, ranging from understanding the general environmental constraints and the customer's agenda to specific contractual, technical requirements, program and project management, and training issues [1]. The assessment approach, with the results delivered to and controlled only by the program manager, also encouraged the assessed program to be open and honest with the assessment teams. This approach, we believe, leads to a truer picture of the state of program performance since the findings are less likely to be *gamed* as in program acquisition oversight audits.

The program performance issues identified by the assessment teams were collected and mapped into a *systemic analysis* database that combined both the quantitative and subjective context data related to the identified performance issues[2]. This analysis approach permitted frequent, relational (cause and effect), and integrated quantitative analysis of the program issues. The results created were realistic, persuasive, and auditable cross-program information that can be effectively used to identify, prioritize, and correct performance shortfalls. Figure 1 provides a relative frequency of occurrence of the types of issues that occurred most often in the assessed programs, issues that materially impacted overall program performance.

Among the recurring issues that were identified, our systemic analysis indicated that the software, systems engineering, and management processes involved in developing and deploying DoD systems were primary contributors to poor pro-

Figure 1: *Critical Program Performance Issues*



gram performance. Process performance issues were of specific concern, and the remainder of this article focuses on our process-related findings.

Process-Related Systemic Analysis Findings

The DoD programs are marked by their complexity and dynamics. The technology embedded in current DoD systems changes both rapidly and repeatedly over the program life cycle. To successfully develop a DoD program requires a highly coordinated team made up of dozens of individual government and contractor organizations that are typically dispersed geographically. The *glue* that holds this complex organization together are the technical and management processes that bring together the technology, resources, knowledge, and skills to execute the program plan. If the appropriate set of processes is not performed, or worse, if the individual processes are inadequate for supporting the program's specific development or evolutionary needs, program success is severely compromised.

A detailed analysis of the program assessment data related to process performance shortfalls led to categorizing the causes of these shortfalls as being related to either *process adherence* or *process capability* (see the sidebar "Process Adherence Versus Process Capability"). The types and relationships of these causative process issues are shown in Figure 2.

It rapidly became clear from our analysis of the systemic issue data that the delivery of adequate *process performance* on any program was directly related both to process adherence (i.e., the ability of an organization to adequately define and implement the technical and management processes required for its programs) and to process capability (i.e., the effectiveness of the defined and implemented organizational processes in meeting a specific program's technical and managerial requirements).

On a positive note, our assessments have not identified any individual programs that are missing the most rudimentary technical or management processes, as shown in the left column of Figure 2. Fifteen years of process improvement efforts have appeared to overcome this one-time common problem. All of the programs that were assessed were well aware of the value of well-defined processes, and of the need to map these processes to the defined business needs within their organizations. Further, most of the organizations assessed were actively involved in a structured process improvement program of some kind.

Our analysis results showed that over 50 percent of the DoD programs that have been assessed have issues involving *process adherence*[4]. This means that the assessments identified performance issues directly related to a program team's ability to implement the technical and management organizational process model or standards that the organization had established as being necessary to ensure program success. The assessment results showed that process adherence shortfalls are most commonly found in the areas of requirements definition, risk management, testing, systems engineering, and technical change management.

As illustrated in Figure 2, our assessment data reveals that there are two general types of process adherence shortfalls. First are the technical or management processes that are *poorly executed*, meaning that they are ineffectively implemented or performed for a particular program. For example, we have found that poor program team communication plagues many programs, largely due to poor implementation of integrated product teams (IPTs) structures within the program. Our analy-

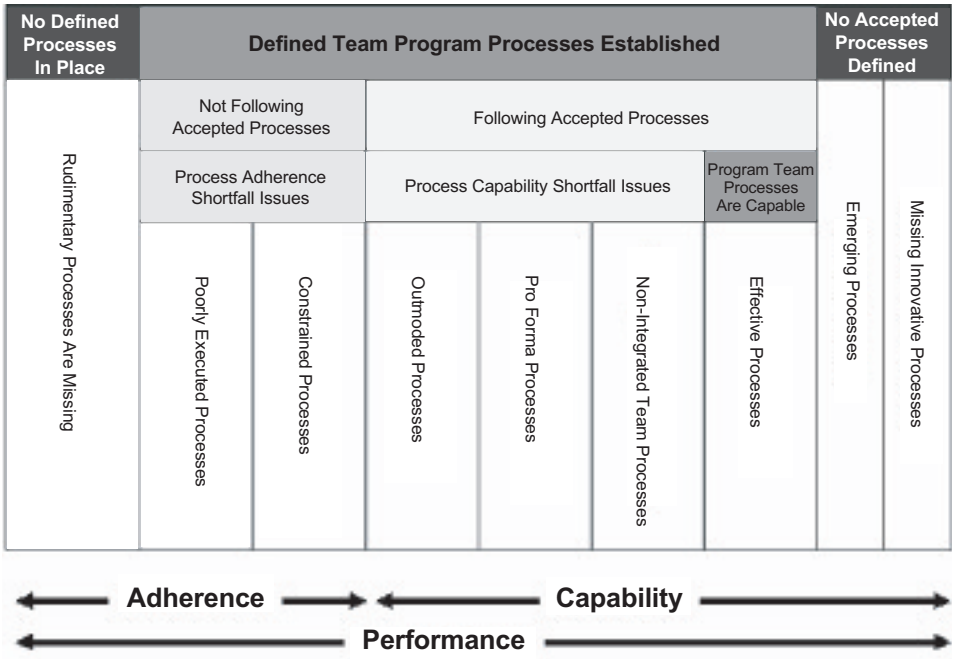
Process Adherence Versus Process Capability

Process performance is the ability to specify, design, integrate, and execute the development processes that meet the specific needs of a unique program. As shown in Figure 2, program process performance is a combination of *both* process adherence and process capability.

Our analysis showed that there are two primary types of process performance shortfalls that impact the overall process performance within a program. The first type of shortfall is related to *process adherence*. Process adherence is defined as the ability of an organization to adequately define and implement the technical and management processes required for its programs. Typically, process adherence adequacy or performance is evaluated against defined process reference models or standards that a parent organization or enterprise has established as being necessary to ensure program success[3]. Common process models include the Software Engineering Institute's Capability Maturity Model® (CMM®), the CMM Integration℠, and ISO [International Organization for Standardization]/International Electrotechnical Commission Standard 15504:1998 for software process assessment. Achievement of a defined maturity level is often viewed as a measure of process adherence for an organization.

The second type of process shortfall relates to *process capability*. Process capability is defined as the effectiveness of the defined and implemented organizational processes in meeting a specific program's technical and management requirements. In general, process capability refers to how well an organization's process models or standards have been adapted and applied to address the specific characteristics and needs of a particular program.

Figure 2: *Types of Technical and Management Process Issues Encountered*



sis further showed that poor risk management and measurement processes were primary causative issues to the IPT problems.

In one program, we discovered that more than 60 IPTs were created, with many of the program team members assigned to six or more individual teams. Furthermore, these IPTs had the responsibility, but not the authority, for making technical decisions (in most cases only recommendations). As one person on the program succinctly put it, "It takes a long time to make a bad decision." We have found that many *best practices* such as IPTs, risk management, or measurement are not being implemented properly on DoD programs, and as a result may cause more problems than they solve.

The second type of process adherence shortfall can be described as *constrained processes*. These are technical or management processes that are not fully implemented or executed because the program team no longer supports or funds them. For instance, we found that the full range of software or systems testing that is planned for at the beginning of a program is often not carried out due to later emerging program budgetary or schedule shortfalls. Testing is in effect traded off against higher-priority program cost or schedule objectives. As a result, errors that should have been discovered during development testing slip into the operational system, causing major problems in the field. One individual on such a program commented, "My worry is not so much whether we deliver on time, but that should the system fail during its operational test, will we be able to tell why?"

Even when program teams were satisfactorily performing the specified organizational team technical and management processes, our analysis showed that the processes themselves were often inadequate to meet the program's performance objectives. In other words, there existed a *process capability* shortfall, indicating that the processes used were ineffective for the situation encountered[5]. As before, several different types of process capability shortfalls have been identified as shown in Figure 2.

The first type of process capability shortfall is the *outmoded process* problem. This occurs when a process model, standard, or practice may no longer be supported, or a specific process-related practice is inappropriate for the situation, e.g., it does not scale for implementation on a large program. While the data showed several instances of these issues, one extreme situation was related to the management of software requirements. In this particular program, the program team was attempting to manage over 20,000 software requirements — *manually*. While the process and related procedures used for requirements was still *theoretically* adequate, it was proving to be extremely labor intensive and error prone. The program had *outgrown* the original process capability. The cost of changing to a new requirements process may have been seen as too expensive and time consuming, so the *outmoded* (and ineffective) process remained in place.

A second type of process capability shortfall is the *pro forma process* approach common to many programs. This occurs when a process is adequately defined but performed in a *check-in-the-box* manner. In other words, the process exists on paper, but no one pays much attention to it. Said another way, there is little value to the output of the process. A common characteristic of pro forma processes is that their outputs are not utilized to make decisions or to improve how the program is being run. Program risk often falls into this category. Risk management is *performed* on most programs, but we found that it is mainly for show. Risks are not communicated and the identified risks frequently do not influence program decision making.

A third type of process capability shortfall identified by our systemic analysis is the *nonintegrated team process*. This occurs when a program team uses several different and often incompatible processes to achieve the same end. This lack of coordination of processes plagues multiple supplier programs where work items are shared. For instance, in one program, because there was a lack of coordinated configuration management processes across the program team, the software product ended up being handled and managed very differently at different times in the development process. This led to major problems on the program as no one could really be certain what version was being used where.

Finally, as shown in Figure 2, there are the processes that are needed for program success, but no accepted practices have been defined. For instance, there is the *emerging process* situation where a new or largely revised process is required, but the program team has failed to define it in sufficient detail. An emerging process does not require adherence to an organizational process standard since the process standard in question may not have been upgraded to include it. For example, many programs appreciate that they have to manage changes in technology over the course of their program development and beyond. However, our assessments have found that many, if not most programs, are managing technological insertion in an *ad hoc* fashion, rather than through any discretely managed process. As a result, technology updates are introduced haphazardly into the development cycle. Since the process for managing technology insertion is defined at the higher Capability Maturity Model® (CMM®) and CMM Integration℠ maturity levels – higher than those usually applied on a DoD program – it is routinely overlooked as being necessary. Additionally, we found that *innovative processes* are required to meet many program's needs and to improve their performance. We found process shortfalls in systems interoperability management, family of systems management, and capability-based acquisition management, among others.

When taken together, process adherence or process capability issues have been found to exist on nine out of every 10 programs assessed. Disturbingly, in 80 percent of the assessed programs where no process adherence issues of merit were found, process capability issues were still discovered. While the program teams are generally aware of the need for improving their adherence to a set of defined processes, the analysis results showed that program team members do not routinely consider their technical and management process capabilities either *individually* or from an *overall program team perspective*. The result is a *program team* process capability and performance shortfall. In short, the full spectrum of a program team's organizational processes are not rigorously evaluated and then tailored to meet the specific characteristics or requirements of the program in question. We expect our results are typical across most DoD programs.

Observations

Our systemic analysis of the recurring program issues led us to several observations about DoD programs and process performance. Our systemic data indicate that new program teams often proceed with processes that are applicable to the previous program they were involved in – not the one they are currently working on. New technology, new policies, new operating environments, etc., pose new process challenges to programs. Unfortunately, these innovative process challenges are often unrecognized until well into a program's development phase – by which time it is too late. The current data suggest that 10 percent to 20 percent

of previously applicable technical or management processes are not appropriate or effective for new program starts. This unrecognized process need, or *process gap*, is especially true in programs where interoperability, systems of systems, family of systems, or network centric warfare requirements are very high.

Second, most adherence-oriented process models or standards are organization-based; they are based on a generalized organizational standard of what *most* projects require, not on what any specific project requires. While these process models are *intended* to be tailored for specific program needs, the data suggest that in practice they often are *not* (see the sidebar "Limitations of Adherence Models"). It appears that many organizations simply apply their standardized, approved corporate process to meet *all* of the diverse programs in their portfolio. Given the high degree of technical and acquisition change that DoD programs face, the inability or unwillingness to adapt defined organizational processes to meet a program's specific characteristics, constraints, and requirements, significant performance shortfalls are almost a given if substantial process tailoring is not done.

Furthermore, evaluations of adherence to a program's process standards are generally made against organizational-based process adherence requirements, not project-specific capability needs. As a result, the evaluation of process adherence can discourage a complete evaluation and tailoring of process standards to meet specific program needs. In other words, bidders on DoD programs end up proposing the use of their corporate or organizational standard processes rather than processes that are tailored to the program they are bidding on. Unfortunately, *one size does not fit all*, and a *best practice* for one program may not work at all for another.

Fourth, there appears to exist a fundamental disconnect between the significance of process adherence and process capability. While process adherence is necessary, it is an *inadequate requirement* for ensuring process performance on a given program. Process adherence is mistakenly seen by too many program teams to automatically equate to process capability. These program teams often do not realize that adherence to a process model equates to real capability only when the process model and the program's technical and management objectives, assumptions, and constraints match extremely well. In a best-case scenario, i.e., optimal program process performance, three items are closely aligned: (1) the specific program's process requirements; (2) the specific implementation of the process model with methods, procedures, and techniques adapted for the program; and (3) the baseline organizational process model or inherent organizational process standard. Since this is rarely the case, there will almost always be a shortfall in program process performance if the process model is not tailored to the situation.

Our assessments also showed that a program team's process capability, as an integrated entity, is rarely considered. A program team's overall process capability does not necessarily equal the sum of the parts of the individual team members. There appears to be little thought given to how the individual processes of the multiple members of a program team may clash or conflict with one another. Just because each program team member may be part of a CMM Level 3 organization does not mean the program team as a whole operates as a Level 3 organization. The program team must recognize early that all of its individual technical and management processes must be tailored first to the specific situation, and then adherence to that tailored process must be enforced. Too many programs reverse the sequence. A program team must measure a project's likelihood of success in relation to *both* process capability and process adherence.

Finally, process integrity is very often reduced due to time, money, or other program pressures. For instance, a program team member may be rated a CMM Level 3 at the beginning of a program, but fall to a Level 2 or 1 by the middle or the end. Similarly, the program team's process maturity may be a Level 3 at program start but it, too, will likely degrade over time. The impact of process degradation is almost never taken into account during program planning, and represents a real threat to program success.

Conclusions

As programs become more complex and as the future military environment becomes more inter-operative, the management and technical process performance required for successful program execution needs to keep pace. From our systemic analysis across recent DoD programs, several conclusions can be drawn:

- Process improvement efforts have overcome the past problem of individual program team members missing rudimentary technical or management processes. However, in all of our assessments, we never encountered a

Limitations of Adherence Models

The Software Engineering Institute's Capability Maturity Model® (CMM®) and CMM Integration℠ have been the favored models against which organizational adherence to software engineering processes are measured. Attaining CMM Level 3 has been the target maturity level DoD programs expect their supplier software development organizations to reach. We have found in our assessments that there is a strong expectation by DoD managers that by achieving CMM Level 3, their software developers (government or contractor) will be equipped to control many if not most of the problems associated with software development on a program.

While setting the CMM Level 3 as a goal to reach has improved software development in DoD programs, it does not guarantee in and of itself that software development on a program will be problem- or risk-free. Many program managers do not understand the limitations of the CMM, and therefore, assume program process performance results that the CMM neither promises nor can deliver.

It is important to remember that the CMM is a *model* aimed at improving an organization's software development process, not the development process of any specific program. The CMM assumes that for an individual program, the organization's standard software process (OSSP) will be tailored to meet the individual program's requirements.

Unfortunately, our assessments have found that tailoring of the OSSP (by which we include the methods/procedures/techniques that implement that process) is often not the case in practice. What usually happens is that the OSSP is used *as is* in a program and little tailoring is performed. This is acceptable if the OSSP and the program-specific software process needs are in close alignment. However, this alignment is unlikely to happen in the general case.

Currently, there is no formal evaluation method that routinely assesses the managerial and technical processes required by the program team as a whole. The data shows that this issue also needs to be addressed if programs are to increase their chances of success.

program where the system was being developed by a single organization. Not only is it now time to focus on process performance rather than just process adherence, but also on *team* process performance as well as individual program team member process performance.

- The DoD program teams must be educated in what process performance means, especially the difference between process adherence – following some repeatable process – and process capability – the true effectiveness of that process in execution. Knowing the difference can be the determining factor between program success and failure.
- The DoD program teams need to evaluate the full spectrum of technical and management process requirements, and then tailor their organizationally based adherence models to meet specific program needs. Careful attention must be given on how to deal with process areas that are outside either the general level of adherence desired or the process adherence model itself.
- The DoD programs should be encouraged to assess their program team's overall process capability. The data suggest that process capability and possibly process adherence be evaluated at request for proposal and at major milestone reviews at the very least to prevent process performance degradation.
- Individual program team members need to collectively ensure that their technical and management processes meet the needs of the program and not necessarily just individual needs.
- The DoD must foster the development of forward-looking, innovative processes and practices that are capable of dealing with the future complexity of DoD acquisitions, developments, and deployments.

Future DoD system complexities will put more pressure on not only software, but also systems engineering and management processes. These processes will need to be more capable, coordinated, and team-integrated. The gap between program expectations and the ability of program teams to produce such systems will continue to grow unless actions are taken to solve the process performance problems in a systemic manner.◆

Reference

1. Baldwin, Kristen, and Laura Dwinnell. "Help Identify and Manage Software and Program Risk." CROSSTALK Nov. 2000: 8-11.

Notes

1. This approach was developed at the Research Development and Engineering Command-Armament Research Development and Engineering Center, Picatinny Arsenal, N.J., and was applied in support of the DoD's Tri-Service Assessment Initiative (TAI). After this article was written, the technical direction of TAI was changed.
2. The results are based upon 23 of the 50 programs assessed. Although over 50 program assessments were conducted, only those that were consistent in terms of issue scope and application of the technical assessment process were included in the systemic analysis program base.
3. These models or standards are designed to meet generic program process requirements, but not the specific process needs of an individual program.
4. This category includes programs with software and other processes that did not meet program team policies or proposed standards, for instance, programs that required CMM Level 3 but the program team was only CMM Level 2.
5. We assume that a process adherence shortfall also translates into a process capability shortfall.

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