

Achieving SA-CMM Level 2 at PM Abrams

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In November 2001, the U.S. Army's Project Manager (PM) Abrams became the first federal organization to achieve Software Acquisition Capability Maturity Model® (SA-CMM®) Level 2 (Version 1.02) for its System Enhancement Package project. This article describes the path taken by PM Abrams to improve its overall acquisition processes, eventually leading to the achievement of SA-CMM Level 2.

The Project Manager (PM) Abrams M1A2 Systems Enhancement Package (SEP) Main Battle Tank is the world's premier ground combat platform. Developed to take advantage of the power afforded by integrated electronics and information technology, the PM Abrams M1A2 SEP tank provides mobile protected firepower to the digitized battlefield and rivals any U.S. Air Force fighter in terms of complexity and technology. Under-pinning this capability is an extensive network of interconnected software – more than 4 million lines of source code – driving eight major digital computer systems over a MIL-STD 1553 databus. The prime integration contractor must integrate various subsystems developed by multiple sources.

The PM Abrams M1A2 SEP project began in 1994 as a Pre-Planned Product Improvement (P3I)¹ program to enhance the capabilities of the fielded M1A2 tanks. Key features of this effort include fire control improvements, the addition of a thermal management system, incorporation of an under-armor auxiliary power unit, and the integration of Force XXI Battle Command Brigade and Below (FBCB2) command and control software.

The M1A2 SEP tank software includes

subsystems provided by Horizontal Technology Integration (HTI)² program managers. The prime integration contractor, General Dynamics Land Systems Division, integrates these subsystems into the system software. The system level software is used by training device developers and by the off-vehicle diagnostics developers.

PM Abrams chose to assess their acquisition processes with the Software Engineering Institute's (SEI) Software Acquisition Capability Maturity Model® (SA-CMM®) in order to drive process improvement within the organization. There were several reasons for the decision to embark on this undertaking, but it was primarily due to these two factors:

- The need to level the playing field with our prime contractor, who was at the Capability Maturity Model® for software (SW-CMM®) Level 3.
- A recent personnel report indicated our command would likely lose more than half of its very experienced personnel before the year 2007. Thus, the SA-CMM process improvement effort was a means to capture this expertise before it was gone.

All levels of PM Abrams (management and staff) participated in preparing

for the assessment. The program manager chartered a Software Acquisition Process Team (SAPT)³ to coordinate the effort. On Nov. 19, 2001, PM Abrams became the first government acquisition organization assessed to be operating at Level 2 of the SA-CMM. This milestone capped off 18 months of effort that began with a baseline assessment in March 2000.

The M1A2 PM Abrams Main Battle Tank SEP was the project chosen for the assessment because it was the most comprehensive software acquisition project within PM Abrams. The processes used on the M1A2 SEP project closely reflect the processes used for all other PM Abrams projects.

Getting Organized

The SA-CMM model assesses five process levels. Table 1 describes these levels. The first order of business for the SAPT was to develop a charter and a plan of action to help us improve our processes and achieve Level 2 (as defined in Table 1). Having a well-defined scope of work is always a key element in any project's success. Putting extra effort, up front, to define this project's scope of work paid big dividends for PM Abrams. Working towards a common goal, using common terminology, and understanding the intent of the various Key Process Areas (KPAs) in the SA-CMM all contributed to PM Abrams' successful achievement of SA-CMM Level 2 for the SEP project.

Because PM Abrams buys systems and not just software, software vs. systems was one of our first scope of work considerations. We had to determine whether to use the existing SA-CMM or to tailor the model to accommodate our systems-oriented organization. We decided that the existing SA-CMM was flexible enough to accurately measure and assess how PM Abrams conducts its business relative to the KPA criteria.

Once these initial tasks were accomplished, we downloaded a survey from the SEI Web site intending to interview key

Table 1: SA-CMM Key Process Levels

Level	Focus	Key Process Areas	
5 Optimizing	Continuous process improvement	Acquisition Innovation Management (AIM) Continuous Process Improvement (CPI)	Higher Quality Productivity Lower Risk
4 Quantitative	Quantitative management	Quantitative Acquisition Management (QAM) Quantitative Process Management (QPM)	
3 Defined	Process standardization	Training Program (TP) Acquisition Risk Management (ARM) Contract Performance Management (CPM) Project Performance Management (PPM) Process Definition and Maintenance (PDM)	Higher Risk Rework
2 Repeatable	Basic project management	Transition to Support (T2S) Evaluation (EVAL) Contract Tracking and Oversight (CTO) Project Management (PM) Requirements Development and Mgt. (RDM) Solicitation (SOL) Software Acquisition Planning (SAP)	
1 Initial	Competent people and heroics		

personnel and to determine how PM Abrams stacked up against the SA-CMM Level 2 criteria. It was here that we ran into a terminology problem. Some words used in the survey had different meanings to the personnel at PM Abrams than the SEI had intended. Thus, many of the original questions had to be re-written in terms that matched the intent of the question to the understanding of PM Abrams personnel. The resulting answers were then compiled and analyzed by the SEI to be used, eventually, by the baseline assessment team.

Baseline Assessment

We contracted with an outside organization to lead the SA-CMM baseline assessment. The resulting assessment team consisted of four internal PM Abrams members and four external members. We reserved two conference rooms, one to be used as the team's war room and the other to conduct the interviews. We then notified everybody well in advance as to who needed to be present for the interviews and when. We also discovered it is a good idea to periodically remind the same personnel regarding when they will be needed and to ask top management to reinforce the necessity of their availability.

We gathered the relevant documents together and catalogued them by creating an index on a CD. Here again, terminology created some problems as we asked for certain documents described by the model that existed at PM Abrams under different names.

We learned three key lessons as a result of our baseline assessment. First, the most significant lesson learned was not to interview groups of people based on functional responsibility within PM Abrams. The functional groups interviewed could answer questions relevant to their division, but gave less informed and less accurate answers to questions outside their area of expertise. To correct the problem, we made sure that the Level 2 assessment group interviews included cross-functional expertise.

The second lesson learned was that we needed to come to a common interpretation of the Transition to Support (T2S) KPA within SA-CMM Level 2 as it applied to M1A2 SEP tank. To the credit of the SA-CMM model, enough flexibility existed to allow it to be adapted to the T2S life-cycle stage of the M1A2 SEP tank. The importance of understanding terminology and mapping it between the model and your organization cannot be over-emphasized.

In our third lesson learned, the baseline assessment indicated that PM Abrams was already performing most of the activities required by SA-CMM Level 2. We just were not documenting the procedures, policies, and charters we were following. PM Abrams, like most Level 1 organizations, relied on its experienced personnel to get the job done, which is fine as long as you never lose those experienced personnel. However, as indicated by the personnel report mentioned earlier, we knew we would lose the majority of these people during the next few years.

Institutionalization

Institutionalizing our processes was probably one of the most difficult aspects of process improvement to implement. The SEI defines institutionalization in the SA-CMM Version 1.02 as follows: "The

“Three elements played key roles in getting the desired... results we needed: training, developing user-friendly tools, and strong support from upper management.”

building of infrastructure and corporate culture that supports methods, practices, and procedures so that they are the ongoing way of doing business, even after those who originally defined them are gone.” Three elements played key roles in getting the desired institutionalization results we needed: training, developing user-friendly tools, and strong support from upper management.

PM Abrams' personnel were trained extensively in both the SA-CMM and our policies, procedures, and the use of our process support tools. We felt that if people understood the maturity model, they would have an easier time understanding the relevance of all the questions being asked during the Level 2 interview sessions. This way they could answer the questions in the context of the model. Part of this training also included mapping terminology between PM Abrams and the SA-CMM.

Two key tools we developed as part of the process improvement effort were a

process improvement Web site and the PM Abrams Digital Archive System (ADAS). These two tools were especially critical to institutionalizing our process improvement efforts. The PM Abrams process improvement Web site provided every employee with desktop access to all our plans, policies, standard operating procedures, definitions, process flow charts, and a monthly process improvement newsletter.

In conjunction, ADAS provided every PM Abrams' employee with desktop access to almost all of PM Abrams functional documents, both historical and current. ADAS is basically an Oracle database that allows the user to search by title, description, point of contact, division, or nomenclature and retrieve the actual document to their desktop (see ADAS sidebar on page 10 for additional discussion).

Strong management support from the very beginning was the third key to our success. Top management provided consistent oversight through the SAPT to ensure that PM Abrams' personnel were using these tools and getting the desired training. This, in turn, resulted in the level of institutionalization required to be assessed as a Level 2 project.

Gap Analysis and Mapping

Gap analysis is an invaluable process/tool that we recommend be done before a CMM assessment. It is a macro-level pre-assessment that identifies organizations' strengths/weaknesses and compares them to a given CMM level. However, it is extremely important that the organization is provided with this gap analysis information in plenty of time to take the necessary corrective action before the actual assessment.

A tool we developed internally to support the gap analysis process was a type of KPA mapping. Our Level 2 KPA mapping, as shown in Table 2 (see page 11), basically was a spreadsheet matrix that mapped each KPA goal, commitment, ability, activity, measurement, and verification to a specific process, policy, standard operating procedure (SOP), or document or artifact within PM Abrams. To satisfy the SA-CMM requirements for each KPA, at least one "X" must be present in each column. In addition to assuring we had sufficient coverage of each KPA for Level 2, this tool also saved a tremendous amount of time during the actual assessment by providing a cross-reference or road map from the KPA being assessed to the actual document or artifact that satisfied the

requirement. This was much more efficient than having to search independently for a document or artifact, since our documents were electronically hyper-linked to corresponding SA-CMM KPA criteria.

SOP Process

Obviously SOPs and policies must be in place for any SA-CMM assessment. The gap analysis helped us identify which SOPs and policies needed to be documented. We developed a very effective and efficient process for implementing our SOPs and policies for the SEP project at PM Abrams.

First we developed a standard template to follow for writing SOPs. This was posted on our SA-CMM Web site and made available to the entire Abram's work force. Next we ensured that an actual subject matter expert(s) was

responsible for writing or updating the SOP or policy. Input for the SOPs was solicited from all relevant personnel to help create buy-in among the work force. Then the SOP was submitted to the SAPT for initial review. From there it was routed to the management steering group, and then ultimately to the deputy project manager for final approval.

Any reviewer could request an addition or change to the document, but the resulting modification would have to go through the entire review process again. For that reason we tried to consolidate as many changes as possible before sending it through the review cycle again. After final approval, the policies and SOPs were posted on our SA-CMM Web site.

This process resulted in policies and SOPs that were useful and relevant to

the organization. This SOP effort also went a long way in helping PM Abrams document the expertise of our personnel – one of our principal goals in the process improvement effort.

Transition to Support

As discussed previously, the T2S KPA proved to be a major stumbling block during the original SA-CMM baseline assessment. Since PM Abrams has not (yet) transitioned the software (and its supporting hardware) to another maintenance organization, there was much discussion during the baseline assessment as to whether this KPA was relevant to PM Abrams. Unable to reach a consensus, the T2S KPA was not assessed during the baseline assessment.

During the months prior to the Level 2 assessment, the SEI and PM Abrams were able to demonstrate that the T2S KPA does allow for a transition to internal software support. (This was the interim reality at PM Abrams made necessary by the ongoing evolution of the tank software systems.) The T2S KPA also allows for the eventual transition to support by another organization prepared to accept this responsibility (the long-term goal for PM Abrams).

After the tank has been delivered to the acquiring organization, the capability to rapidly deploy software changes must be maintained throughout the tank's 30-year life cycle. A plan for the eventual transition of the tank system to a support agency is essential to ensure that system readiness is maintained. PM Abrams demonstrated to the SEI their readiness for this eventual transition to support. This section describes the M1A2 SEP program's approach to meet the SEI's SA-CMM Level 2 T2S KPA and ensure that an adequate life cycle software support management process was in effect for the M1A2 SEP.

SEP software changes were driven by evolving mission requirements, HTI mandates, systems upgrades, obsolescence, and field problem fixes. The complexity involved in orchestrating the implementation of so many external software inputs led to the decision to keep the SEP software acquisition management function within PM Abrams through the end of production. As such, the T2S plan took on a somewhat different flavor than traditionally expected, highlighting one of the primary benefits of using the SA-CMM model – adaptability. The model was flexible enough to allow it to be tailored to meet the unique needs of the PM Abrams program.

PM Abrams Digital Archive System (ADAS)

The PM Abrams Digital Archive System (ADAS) began in May 2000 as an initiative to reduce paper copies of documents by imaging them to CD disks and cataloging them in a Microsoft Access Database. ADAS also played a key role in our successful achievement of SA-CMM Level 2 by allowing the assessment team to search and quickly retrieve documents as requested. Initially, PM Abrams successfully imaged more than 4,000 documents (representing over 500,000 pages), reducing the need for multiple file cabinets. After the imaging was completed, a user needing a specific document would fill out a request form and submit it to the ADAS administrator who would then forward an electronic copy to the requestor.

Later, a process was developed to improve turnaround time and user accessibility to these archived documents. The digitized documents were warehoused in an Oracle database and accessed by any authorized user via the local PM Abrams process improvement Web site. The ADAS user/database interface was developed using Oracle Forms. This Web-based, real-time document retrieval system now allows the user to both view and submit documents into ADAS.

Document security is managed by built-in Oracle Row-Level Security thus ensuring users only have access to appropriate data. To prevent any potential loss of information, the ADAS database is backed up regularly.

The following system requirements must be met on the user's PC in order for the program to operate:

- Installed Oracle JInitiator Applet.
- Internet Explorer 5.0 or above.
- Windows 95/98/ME/NT/2000.
- Pentium 90Mhz or higher.
- 16MB of system RAM or higher.

The process is simple for any authorized user to follow. Once the applet is started, a valid username and password will take the user to a search screen. Here, several variables can be used to search for specific documents, including author, any word within the document's title, a short description of the document, nomenclature, part number, or the name of any of the divisions within PM Abrams. The system will return a list of all documents containing the input criteria. At this point the user can select the document he/she wishes to use.

ADAS is an excellent way to share information, archive historical documents, and ensure personnel are using the latest approved document. To date there are more than 5,600 stored documents in ADAS, available to three different access groups: public, government, and management. ADAS is predicted to grow to more than 10,000 documents in the next year and will continue to improve communications within PM Abrams. ADAS has improved the management of documents and increased awareness about specific program information. ADAS has improved interdisciplinary communications and taken the PM Abrams program one step closer to a paperless environment. ADAS will continue to be refined and revised as technology changes and as we continue to receive feedback.

**Program Management Key Process Area
Mapping Abrams Processes to
KPA Verifications (V), Measurements (M), Activities (AC), Abilities (A), Commitments (C), and Goals (G)**

PM Abrams Division	Processes	Abrams SOP#	Artifact	V1	V2	M1	AC1	AC2	AC3	AC4	AC5	AC6	AC7	A1	A2	A3	A4	C1	C2	G1	G2	
PMO	Program Manager & Project Managers have a charter		PM Charter & APM Charter															X	X			
ALL	Each Division Manager has a "Roles and Responsibilities" document that defines each division's functions.		Briefing Charts	X															X		X	
PMO	Multi-year Authority		Multi-Year Contract					X			X	X		X				X	X	X	X	
PMO/Engineering	A CPR is required from the contractor for every major program. Tracks project progress.	AB-006	Cost Performance Report (CPR)	X	X	X			X	X	X	X	X	X	X	X	X		X		X	
ALL	Weekly PM report documenting individuals key activities/accomplishments.	AB-003	One - liners	X	X	X										X					X	
PMO	O & S ownership cost reduction.	AB-007	TOCR Plan (PILOT)		X								X					X	X		X	
PMO	Cost Validation (AMSTA-RM-V)	AB-008	E-mail Certification from Cost Analysis Directorate			X		X													X	
ALL	PATs are formed for major projects.	AB-005	PAT Charter				X	X		X				X	X			X	X		X	
PMO	Budget Execution	AB-043	Customer Files (MIPRs & customer checks) , TACOM Ledger (SOMARS), PM Ledger (PEST), Procurement Work Directive (MIPR), DASIS	X		X				X	X	X		X							X	
PMO	Internal Controls	AB-044	Obligations Forecast (PROPS), FLASH Report, Variance Analysis, Year-end Certification Form, ULO Printout	X		X				X	X	X		X							X	
PMO	Budgeting	AB-045	P-Forms & R-Forms (PB, POM, BES)	X	X	X								X							X	
PMO	Report Management Activities to DA (monthly) regarding M1A2 status.	AB-009	PM-Monthly Report (MAPR)	X	X	X			X	X			X	X	X	X	X		X		X	
PMO/ALL	Document agreements between PM Abrams and other Gov't & non-Gov't entities.		MOA					X	X										X		X	
PMO	Ensure that policies, procedures, specifications, etc. are being followed.		Audit Reports	X	X	X	X	X		X	X	X		X	X				X	X		X
PMO	Annual documentation of major events that occurred in the program.	AB-051	Annual Command History	X	X	X														X	X	
PMO	Historical documentation of PM Abrams events (updated annually).	AB-052	PM Abrams History	X	X	X														X	X	
PMO	Life Cycle Cost Estimates (done as needed).		POE	X	X					X		X	X		X	X		X			X	
PMO	General Cost Estimates/ Economic Analysis (done as needed).		Price & Availability Reports, Various Reporting Formats	X		X				X	X		X								X	

Note: The first four column headings denote the following: the relevant organization (division) within PM Abrams, a brief description of the process currently in use, any applicable SOPs, and all relevant documents/artifacts. The processes and artifacts columns contain terms with acronyms that may be unique to the U.S. Army or PM Abrams. Such documents and processes should correspond to the unique way your organization currently conducts business.

Table 2: Project Management KPA (Level 2) Mapped to Internal PM Abrams' Practices

Transition Steps

From the model, the purpose of transition to support is to provide for the transition of the acquired software products to the software support organization. This effort should begin with initial program planning and the earliest definition of software requirements, and end when the responsibility for software acquisition shifts to the identified software support organization. From PM Abrams' perspective, transition to support requires that plans for transitioning software be developed and executable. Resources required for this transition are identified, funded, and available when needed. The software support contractor team and software support organization must be fully knowledgeable of software engineering and support environments. The development

and configuration control infrastructure must be defined and maintained throughout the transition process.

The model requires that a transition to a software support organization must be planned. Since PM Abrams software development for the SEP program is still a work in progress with a projected development requirement for several years, the assessment focused on the transition from engineering and development to logistics and field support of the software products.

Even though acquisition management currently resides in the project office, transition to a support organization is well under way. The eventual software support organization has been identified. The Next Generation Software Laboratory in the Tank-Automotive Research Develop-

ment and Engineering Center (TARDEC) has demonstrated the capacity and capability per the SA-CMM model to provide software acquisition and development support. This organization currently does software support for the standard M1A2 software. Personnel from TARDEC are dedicated to PM Abrams' software acquisition and currently work closely with their PM Abrams counterparts.

An M1A2 systems integration laboratory is up and operational and plans and budgets are in place for SEP. Support agreements are in place with TARDEC, General Dynamics Land Systems (GDLS, the tank's prime contractor), and PM Abrams to ensure continued support for the M1A2 SEP tank. From an acquisition perspective, the related development and support contracts include provisions to

ensure that a transition to support can take place. Ownership of data rights, support documentation, and system and software integration laboratory (SIL) components are retained by PM Abrams.

In preparing for the assessment and to improve the overall acquisition process, PM Abrams did ensure that the following activities must be performed while preparing for a potential transition to a new support agency:

- Essential engineering documentation must be identified, developed, reviewed, delivered, and maintained.
- The infrastructure and Computer Aided Software Engineering (CASE) tools used to develop, compile, build, and test the software products must be identified and procured by the supporting agency.
- The supporting agency must be equipped with the target hardware and the platform system for SIL.
- The supporting agency must be equipped with compatible development platforms in order to properly host the CASE tools needed for development.
- The supporting agency must have the facilities, expertise, and domain knowledge.
- Configuration items shall be defined and placed under configuration control.
- Source code files and program listings (i.e., software product specifications) must also be provided to the supporting agency.
- Funding for support planning, preparation activities, and the software support itself should be included in the life-cycle budget planning.
- Transfer of proprietary rights, licenses, and warranties to these software products have to be planned with future support and modifications considered.

Long-Term Support

The PM Abrams SEP tank, as with many major weapons systems, has a life-cycle span of 30 years or more. The software that brings these systems to life will evolve over its life span to meet the challenges of new threats, new operating environments, and hardware/software obsolescence. There is always a possibility that the original developer and/or the acquiring organization may eventually cease to support these software products. The original developing organization (i.e. contractor) could decide that supporting the software product may not be financially rewarding and thus not in their best business interests. The original developer may be out of

business while the system still has many years of use left in its life cycle. The acquiring organization may be refocused, downsized, or eliminated. The people who originally developed and acquired the software products will most likely not be the people who support and manage the software.

In addition to the long-range plan to transition the software to a support organization, PM Abrams is planning to ensure that software support can continue should the original software developers or PM Abrams itself cease to exist.

The M1A2 SEP T2S strategy will ensure that all necessary engineering tools and practices are in place and updated to support a mission transfer. While often difficult to focus on T2S during the early phases of the acquisition process, failure to include postproduction acquisition planning with T2S in mind can leave your system unsupported.

“The most significant lesson learned was not to interview groups of people based on functional responsibility within PM Abrams.”

Summary

Several personnel issues were very important to our successful achievement of SA-CMM Level 2. First, our top management believed very strongly in the benefits of process improvement and the SA-CMM. They ensured that process improvement was a top priority in the organization and provided the resources necessary to accomplish this task. PM Abram’s management steering group provided experienced people from each of their divisions to serve on the SAPT. The SAPT was then trained in process improvement and given the time necessary to accomplish these goals. Without the strong commitment from top management, we probably would not have been able to attain our goals in process improvement.

Terminology was another area in which extra effort early in our process paid big dividends. We discovered from our baseline assessment that PM Abrams personnel were having difficulties answering CMM questions because of some terminology differences. For example, *project manager* in

the CMM terminology was equivalent to *product manager* in PM Abrams’ terminology. So we identified numerous terminology differences and addressed them through work force classroom training, mock-assessments, and e-mails.

As a result of these efforts, we experienced little (if any) terminology difficulties during the actual SA-CMM Level 2 assessment.

Metrics/measurements turned out to be less of an effort than we originally imagined. The key for Level 2 was to ensure that we were tracking the internal status of our project for each KPA. It can be as simple as meeting minutes or tracking the status of assigned tasks. Even though we had some more formal measurement tools in place, internal status tracking is what is required for the SA-CMM Level 2 Measurement & Analysis category.

As for PM Abrams’ future plans regarding SA-CMM, initially we intend to expand our Level 2 processes to all projects within the PM. Beyond this, PM Abrams will focus on improving our risk management activities – a key SA-CMM Level 3 KPA.◆

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Notes

1. Pre-Planned Product Improvement (P3I) stands for planned future improvement of developmental systems that go beyond the current performance envelope to achieve a needed operational capability.
2. Horizontal Technology Integration (HTI) stands for the integration and application of common technologies across multiple systems.
3. The Software Acquisition Process Team (SAPT) is PM Abrams equivalent to the Software Engineering Process Group (SEPG).

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