

Appraisal using the Federal Aviation Administration's Integrated Capability Maturity Model[®] (FAA-iCMM[®])

Larry LaBruyere
TRW - FAA/AUA TAC
475 School Street, SW
Washington, DC 20024

Abstract. The Federal Aviation Administration (FAA) has been improving its processes for several years. As part of this process improvement effort they recently completed an appraisal of eleven programs representing the full systems engineering and acquisition lifecycle, against the FAA's Integrated Capability Maturity Model[®] (FAA-iCMM[®]). This paper describes the method used and identifies lessons learned.

INTRODUCTION

FAA-iCMM. In November 1997 the FAA published its FAA-iCMM (Ibrahim et. al., 1997) to improve the acquisition, engineering, and management practices of the FAA. The FAA-iCMM integrates three CMMs the FAA had been using separately: the SW-CMM (Paulk et al. 1993), SE-CMM (Bate et al. 1995), and SA-CMM (Ferguson et al. 1996). These CMMs have different architectures, domains, and multiple appraisal methods. The FAA-iCMM was used as a reference model for the CMM[®] IntegrationSM (CMMISM) – SE/SW, V. 1.0 (Ahern et. al. 2000) which is similar in concept. The FAA-iCMM is continuing to evolve and a new version is expected out in 2001. Experiences in using this model at the FAA have been described in previous documents (Ibrahim, 2000).

FAM. The FAA-iCMM Appraisal Method (FAM) was published in (Ibrahim et. al., 1999) to provide a method of appraising FAA organizations/projects to identify their strengths and weaknesses, provide recommendations, and identify the capability and maturity levels against the FAA-iCMM. The FAM is based upon several existing appraisal methods currently used against the various CMMs: CMM-Based Appraisal for Internal Process Improvement (CBA IPI) (Dunaway et al. 1996), Software Capability Evaluation (SCE) (Byrnes et al. 1996), Interim Profile (IP) (Whitney et al. 1994), and Systems Engineering Capability Maturity Model Appraisal Method (SAM) (Kuhn et al. 1996). These methods were integrated and tailored to adapt them to the FAA-iCMM's continuous with staging architecture. The full standard method is known as the full FAM. The FAM also provides several

variations to address organizational needs at various stages of process improvement. These variations include:

- Facilitated Discussion Appraisal (describes the Process Action Team's process definition and implementation and self appraisal process, i.e., As-Is process, Gap analysis, To-Be process, and implementation);
- Document-intensive Appraisal (detailed document and artifact review, with interviews being only a guide to the documentation);
- Questionnaire-based Appraisal (QBA) (based on the IP questionnaire appraisal method);
- Interview-based Appraisal (involves interviews only, with no document review, based on the SAM); and
- Full External Evaluation (based on the SCE for appraisal by an external entity).

All FAM methods provide strengths and weaknesses, but only the Full FAM and the Full External Evaluation can provide ratings (the QBA can produce interim ratings). In addition the full FAM has been mapped to the CAF (Masters et al. 1995) and to ISO/IEC 15504 (ISO/IEC TR 15504, 1998), to ensure that it follows the Software Engineering Institute's requirements for appraisals.

The FAA has performed at least one of each of the appraisal variations with the exception of the Full External Evaluation. During the period from September 1998 to December 2000 there were ten Full FAMs performed on different parts of the FAA. The scope of these FAMs has always been capability level 2 in each Process Area (PA) within the selected scope for appraisal, with six appraisals looking also for maturity level (all nine PAs staged at level 2; see Table 1). This paper discusses the appraisal conducted the first quarter of 2000 as well as the follow-up that was performed in October 2000 for those programs not reaching the initial goal in the spring.

Needs
Requirements
Outsourcing
System Test and Evaluation
Transition
Project Management
Contract Management
Quality Assurance and Management
Configuration Management

Table 1. Maturity Level 2 FAA-iCMM PAs

FAA 2000 FAM (1ST QUARTER)

Scope. The on-site phase of this appraisal started on 24 January 2000 and the final briefing was provided on 15 March 2000. The scope is shown in Table 2. The sponsors of the appraisal were Steve Zaidman (Associate Administrator for Research and Acquisitions - ARA), Ray Long (Director Airway Facilities Operational Support - AOS), and James H. Washington (Director of Air Traffic System Requirements - ARS). This appraisal covered the FAA's Acquisition Management System (AMS) lifecycle from needs elicitation through system maintenance.

Organizational	11 programs with program specific results
Model	Maturity level 2 (capability level 2 in the nine PAs).
AMS Life Cycle (FAA, 1997)	Investment Analysis (pre-project) - two programs, Solution Implementation – seven programs, and In-service Management (operational support) - one program with one in transition from Solution Implementation to In-service Management.

Table 2. FAM Scope

Goals. The goals of the appraisal were:

- Evaluate ARA Performance Goal 7 satisfaction (this first goal applied only to the eight ARA programs; the three non-ARA projects had a similar goal):
Enabling Process Improvement using the FAA-iCMM: Institutionalize maturity life cycle processes that enable high quality solutions to Agency and user needs, predictable cost and schedule, and increasing productivity. To accomplish this:
75% of selected product teams will achieve FAA Integrated Capability Maturity Model (FAA-iCMM) maturity level 2 by December 1999.
- Motivate and focus the process improvement

effort.

- Promote buy-in, learning, participation, and involvement.
- Provide visibility into current status; track our improvement effort.
- Provide focused program feedback to support action planning and plan adjustment.

APPRAISAL ACTIVITIES

The following identifies the activities that make up the three parts of a FAM appraisal: Pre-On-Site Activities, On-Site Activities, and Follow-on Activities.

Pre-On-Site Activities. Plan and Prepare Appraisal. These activities were accomplished prior to January 24.

Obtain Sponsor Commitment. The Lead Appraiser works with the sponsor to agree on the concept of the appraisal and to define the appraisal goals and requirements. Commitment is obtained from the sponsor to provide the resources required.

Select Appraisal Scope. The Lead Appraiser, with concurrence from the sponsor, selects the appraisal type, tailoring options, and the organizational and FAA-iCMM scope.

Select Appraisal Team. The Appraisal team is identified. Team members for this appraisal included:

- Larry LaBruyere, (TRW/AIO-appraisal team lead)
- Roland Aikens (NISC/ARX-200-organizational appraisal representative)
- Eunice Harwell (AOS-organizational appraisal representative)
- Bill Howard (TRW/AUA-organizational appraisal representative)
- Reid Howard (AND-organizational appraisal representative)
- Joye Coffey (TRW/ACM)
- Courtney Dudley (ACT)
- Carlos Galvin (Software Productivity Consortium)
- Linda Ibrahim (AIO-200)
- John Seger (ASU-200)

The appraisal team lead duties include:

- perform or oversee the appraisal
- provide appraisal materials and guidance as needed
- train the appraisal team on the model and method
- lead the appraisal process
- provide FAA-iCMM and FAM expertise
- verify the FAM method or variation is being followed.

The organizational appraisal representative role is to be the organizational or site expert and is the point of contact for the team, especially for follow-up activities. Each organization being appraised has an organizational appraisal representative on the appraisal team. It should be noted that AUA and AND are part of the ARA organization within the FAA, and both had programs being appraised.

Plan Appraisal Details. The Lead Appraiser develops an FAA-iCMM appraisal method (FAM) plan to identify the appraisal scope, appraisal risks, identify appraisal team members, and plan the appraisal activities. Any tailoring of the FAM is identified in the plan.

Train Team. The Lead Appraiser trains the team on the FAA-iCMM and FAM and team building is facilitated.

Administer Questionnaire. Tailor, administer, collect, and record questionnaires. In this case we incorporated the QBA questionnaire into the Full FAM.

Develop Exploratory Questions. The appraisal team reviews an initial set of documents reflecting the organization's process, and the questionnaire results and develops the initial exploratory questions.

On-Site Activities. Conduct Appraisal. These activities were accomplished from January 24 through March 15.

Conduct Opening Meeting. The sponsor opens the meeting to show support and urge participants to be forthcoming in interview sessions. The Lead Appraiser describes the appraisal process.

Interview groups and Individuals. Interviews are performed by the appraisal team with the following people/groups:

- Project leaders - individually interviewed
- Senior/middle managers - interviewed as a group
- Functional area practitioners - interviewed in groups of 6-12 people. (e.g., requirements, systems engineering, system test, transition, contracts, quality assurance, and configuration management).

Review Documentation. The team reviews the appropriate documentation throughout the appraisal process.

Consolidate Data. At the end of each interview the appraisal team summarizes and consolidates information into a manageable set of observations categorized with reference to the Process Areas (PAs) of the FAA-iCMM. Observations are validated using rules of corroboration.

Develop Draft Findings. The appraisal team generates Draft findings from the observations. Ratings are not considered in this phase.

Present Draft Findings. The Draft findings are presented in multiple sessions to protect confidentiality of the participants. The purpose of this presentation is to obtain feedback from the appraisal's participants on the accuracy of the Draft findings.

Develop Ratings. When the team has achieved full coverage of the FAA-iCMM, the organization, and life cycle, the rating process is begun. Each goal for each PA is rated.

Develop Final Briefing. Final findings are prepared.

Brief Sponsor. The Lead Appraiser presents the results to the sponsor.

Present Final Briefing. The Lead Appraiser presents the results to the appraised organization.

Conduct Wrap-up. The Lead Appraiser collects feedback from the appraisal participants and team on the appraisal process.

Follow-On Activities. Report Results. These activities were accomplished immediately after March 15.

Prepare and Deliver Appraisal Report. The appraisal report is prepared to provide further details of the appraisal findings and recommendations.

Manage Records. Interim and final appraisal data are properly distributed/dispositioned.

PERFORM APPRAISAL

Location. Since the people to be interviewed were dispersed across two major locations, and due to the size of the appraisal, the schedule was separated into three phases. During phase 1 the appraisal team focused on four programs in the Washington, D.C. area. This approach allowed the team time to bond and begin to work together. In phase 2 the appraisal team went to the William J. Hughes Technical Center in Atlantic City, New Jersey and appraised one program. While the team was in New Jersey, interviews were also held with people from other programs being appraised in other phases. Phase 3 was done back in Washington, D.C. for six programs. The high level schedule is shown in Table 3.

Administer Questionnaire	Jan 4 - 19
Train Team	Jan 18 - 19
Phase 1 (in DC)	Jan 24 - Feb 3
Phase 2 (in Atlantic City)	Feb 14 - 18
Phase 3 (in DC)	Feb 25 - Mar 10
Draft Findings	Mar 13
Final Findings	Mar 15

Table 3. FAM Schedule

Appraisal Team. The ten-person appraisal team was selected from across the FAA (both FAA employees and support contractors) and included an external member from the Software Productivity Consortium. Those internal FAA members with domain knowledge came from various directorates within the FAA representing each of the PAs being appraised. Each member attended a two-day FAM training class (FAA-iCMM training was a prerequisite) and two-day preparation time prior to phase 1 and again for phase 3. This preparation time included a 45-minute briefing from each product lead for the programs to be appraised in that phase and a team review of the questionnaire results. The questionnaire had been completed during the first two weeks in January 2000. The team was divided into three mini-teams of three people each (Needs / Requirements / Outsourcing; System Test and Evaluation / Project Management / Contract Management; and Transition / Quality Assurance and Management / Configuration Management). See Table 4 for a summary of the statistics collected during the appraisal.

Participated in the discussions during the appraisal	160
o project leaders	16
o senior managers	13
o practitioners	131
Number of interview sessions	44 (1-1.5 hours each)
Number of documents or groups of artifacts reviewed	Over 500
Completed questionnaires	357

Table 4. FAM Statistics

RESULTS

Maturity Level 2. The appraisal resulted in four of the programs reaching maturity level 2. It should be noted that achieving maturity level 2 in the FAA-iCMM is equivalent to achieving maturity level 2 in the SW-CMM and SA-CMM, in addition to achieving capability level 2 in the corresponding PAs of the SE-CMM. Most of the other programs got capability level 2 in at least eight of the process areas.

The two most deficient areas were in Project Management and in Quality Assurance and Management. For Project Management, although most projects had a way of doing estimates, in many cases it was not documented in a repeatable manner. Although most had a documented way of performing Quality Assurance and Management, in many cases they had only performed the process once.

Follow-up. Four of the programs requested follow-up appraisal for October 2000. To accomplish this a subset of the original team containing five members was formed. Only the PAs that did not receive a capability level 2 were appraised for each program. This means that not all programs had the same PAs appraised in the follow-up. This follow-up took a total of four days and was done in Washington, DC (three days) with one day at Atlantic City, NJ. The FAA has a shuttle that allowed the team to travel round trip on the same day as the appraisal. It was decided to give any program that did reach capability level 2 in all nine PAs (but did not receive that rating in the spring appraisal) a "Provisional Maturity Level 2". Three of the four programs obtained that rating. The other program still had weaknesses in Quality Assurance.

Lessons Learned. There are many advantages to performing an integrated appraisal. The CMMs have many commonalities in concepts that can be appraised at one time making it more efficient to look at them together. The people being appraised many times do not separate the CMM disciplines in their own minds. Therefore, appraising them at once is more understandable by those being appraised. The artificial barriers of doing separate domain appraisals are removed. The integrating of appraisals has significantly decreased the impact on the projects. In the past, various sources (some external to the FAA) have requested different types of appraisals. The maintenance organization was using the SW-CMM and performing CBA IPIs. The systems engineering organization was using the SE-CMM and performing SAMs. The Government Accounting Office performed a SCE against the SA-CMM. The projects were constantly being asked to support these appraisals that basically covered what they did from different perspectives. The integrated appraisal allowed the FAA to obtain more concise, understandable information, with only a single appraisal of the organization. As a result of the FAA performing internal integrated appraisals, the external and internal requests for appraisals have been significantly reduced. The FAA has found that using the integrated model and appraisals is a major step in improving the processes and final products/services provided by the FAA.

There were a few problems with the appraisal discussed in this paper; most were identified as risks in the appraisal plan. The size of the appraisal, both

in terms of number of projects appraised and length of time to do the appraisal, raised several issues. With the appraisal being scheduled for the winter months, there was a strong possibility that snow could hamper the appraisal. Two days were lost as a result of snow. However, free time was included between the phases to allow for weather-related factors and team fatigue. The schedule also called for only two 1.5 hour interviews per day. This was done to allow for document reviewing, consolidation, and to reduce the need for long working days for the team. Due to rescheduling and some follow-up interviews, the team was not always able to adhere to the original schedule, and there were still a few long days.

The appraisal team had laptops (at least one for each mini-team, plus one for the data manager, and one for the appraisal team lead) that were networked together. This allowed files to be transferred easily and with the aid of a video projector allowed them to be viewed/edited by the team during review sessions. This approach proved to be very useful.

One of the major impacts of the appraisal was the requirement to provide project-specific findings. In order to accomplish this, observations had to be separated by project, which would allow findings by project. The rules of corroboration were maintained for the project findings. Observations were maintained in project specific Word file tables that were converted to findings by removing source information. These Word documents were then shown to each project lead for draft findings and the final was provided to each project. This was done in addition to the normal two briefing sessions, at the organizational level, which was done without project attribution. The team found that keeping detailed data for each of the eleven projects was very difficult. This problem was compounded by the way the group interviews were done. Group interviews were performed by functional area, with multiple projects done at the same time. This was more efficient and was useful in identifying organizational issues, but made identifying project findings more challenging. It should be noted that an organizational or project appraisal for maturity level 2 can be performed in one week, if project specific results are not requested.

One of the "projects" was only a functional team performing pre-planned product improvement for a large project. The team found it difficult to separate their activities from the large project as a whole. Many of the PAs were rated "Not Applicable" and many applicable PAs were only partially performed by the functional team. Other aspects were generally the responsibility of the project. While their effort had produced many good results for both their team as well as the project as a whole, the appraisal team found that in many cases the goals of the model were not reached. This "project" did not participate in the follow-up appraisal. While the FAA-iCMM can and

should be used to appraise functional areas as well as projects and organizations, only projects and organizations should be appraised using the Full FAM. Projects and organizations that are "service" organizations are helped by performing a full FAM, and have been successfully appraised at the FAA. Many of the FAM variations are still applicable.

Setting process improvement goals is very important for an organization. When setting these goals it is wise to consider how they will be measured. Appraisals are more efficient when performed at the organization level; however, there are several situations when project specific appraisals are useful. When an organization is beginning process improvement, they may decide to pilot their best practices on specific projects prior to expanding to the entire organization. The appraisal can be done more efficiently if multiple organizations/projects with similar management or processes are appraised jointly. There are several other techniques for providing projects specific feedback without providing specific ratings. One of these techniques is to provide organizational findings and ratings, then to develop a mapping of each finding to each project. Each project specific mapping is then provided only to that project. This is useful in satisfying the goals only if the goals are worded in a way to not dictate ratings.

The FAM has helped identify problems with the FAA-iCMM that the evolution team can use to maintain the model. The FAA-iCMM was in use even before it was published in November 1997. The model was intentionally held stable during this period to avoid confusion among the teams doing process improvement. In some cases terminology was difficult to understand. There is some duplication among PAs (intentional at times) and a few typographical errors. As a result of the appraisal and analysis of the results of the process improvement effort, the FAA can not only plan the projects and organizations process improvement, but also the evolution of the model itself.

SUMMARY

Progress. The FAA has made major progress in process improvement over the past several years. The integrated model has helped focus people on a common goal, and has aided the improvement against all three of the integrated CMMs simultaneously. Many of the problems encountered, and listed here, are similar to those encountered by any large organization. Senior management was committed to process improvement from the beginning, but some did not fully understand the scope of the effort required and their roles within that effort. Initial goals were set without fully understanding the process improvement culture within the FAA; however, these goals played a major part in expanding process improvement within the FAA. As

understanding of this culture has increased management's knowledge of process improvement and ability to perform their process improvement roles has also matured. There are still many areas within the FAA that have not yet applied the process improvement approach. However, the number of FAA organizations that realize the importance of process improvement is growing rapidly, and these new organizations are now participating in process improvement activities. As a result of this, the FAA organizations currently involved in process improvement continue their journey, as newer groups start their journey. The Full FAM has been very useful in identifying areas of strengths and areas for improvement. The integrating of appraisals has significantly decreased the impact on the projects and provides more concise, complete, and understandable results than doing separate appraisals. It is hoped that the FAM variations, that do not provide ratings, can be used more in the future to reduce cost and help to continue to focus the FAA on process improvement.

REFERENCES

- Ahern, Dennis, et. al. *Capability Maturity Model – Integrated for Systems Engineering/Software Engineering, Version 1.0 (CMMI – SE/SW, V. 1.0)*, CMU/SEI-2000-TR-019, ESC-TR-2000-019, August 2000
- Bate, Roger, et. al., *A Systems Engineering Capability Maturity Model*, Version 1.1, November 1995, SECMM-95-01, CMU/SEI-95-MM-003, Software Engineering Institute, Carnegie Mellon University, Pittsburgh, PA.
- Byrnes, Paul and Phillips, Mike, *Software Capability Evaluation, v3.0 Method Description*, CMU/SEI-96-TR-002, April 1996.
- Dunaway, Donna and Masters, Steve, *CMM-Based Appraisal for Internal Process Improvement (CBA IPI): Method Description*, CMU/SEI-96-TR-007, April 1996.
- Federal Aviation Administration (FAA), *Federal Aviation Administration Acquisition Management System*, June 1997.
- Ferguson, Jack, et. al., *Software Acquisition Capability Maturity Model (SA-CMM)*, Version 1.01, December 1996, CMU/SEI-96-TR-020, Software Engineering Institute, Carnegie Mellon University, Pittsburgh, PA.
- Ibrahim, Linda, et. al, *The Federal Aviation Administration Integrated Capability Maturity Model (FAA-iCMM)*, Version 1.0, November 1997.
- Ibrahim, Linda, et. al, *The Federal Aviation Administration Integrated Capability Maturity Model (FAA-iCMM) Appraisal Method (FAM)*, Version 1.0, April 1999.
- Ibrahim, Linda, *Using a Integrated Capability Maturity Model – The FAA Experience*, Proceedings of the Tenth Annual International Symposium of the International Council on Systems Engineering, page 643, May 2000.
- ISO/IEC TR 15504 Information Technology – Software Process Assessment, 1998
- Kuhn, Dorothy, et. al, *A Description of the Systems Engineering Capability Maturity Model Appraisal Method*, Version 1.1, CMU/SEI-96-HB-004, March 1996.
- Masters, Steve and Bothwell, Carol, *CMM Appraisal Framework*, Version 1.0, CMU/SEI-95-TR-001, February 1995.
- Paulk, Mark, et. al., *Capability Maturity Model for Software*, Version 1.1, February 1993, CMU/SEI-93-TR-24 and CMU/SEI-93-TR-25, Software Engineering Institute, Carnegie Mellon University, Pittsburgh, PA.
- Whitney, Roselyn, et. al, *Interim Profile: Development and Trial of a Method to Rapidly Measure Software Engineering Maturity Status*, CMU/SEI-94-TR-4, March 1994.

BIOGRAPHY

Mr. LaBruyere has been with TRW for over 18 years and supports the Federal Aviation Administration's Chief Information Officer on a technical assistance contract supporting process improvement based on the FAA-iCMM. He participated in the authoring of the FAA-iCMM and FAM. Mr. LaBruyere is an "Authorized CBA IPI Lead Assessor" for the SW-CMM and participated as an evaluator in several evaluations. He was the Appraisal Team Lead for the FAM described in this article. He is an authorized instructor for Practical Software and Systems Measurement. He obtained an MS from American University, and a BA from Anderson University.

CMM[®] Integration and CMMI are service marks of Carnegie Mellon University.

Capability Maturity Model and CMM are trademarks of Carnegie Mellon University.