


The Impact of Conducting ATAM® Evaluations on Army Programs

Software Engineering Institute
Carnegie Mellon University
Pittsburgh, PA 15213

Robert L. Nord, John Bergey,
Stephen Blanchette, Jr., Mark Klein
May 2009

© Carnegie Mellon, Architecture Tradeoff Analysis Method, and ATAM are registered in the U.S. Patent and Trademark Office by Carnegie Mellon University.

 **Software Engineering Institute** | CarnegieMellon © 2009 Carnegie Mellon University

NO WARRANTY

THIS MATERIAL OF CARNEGIE MELLON UNIVERSITY AND ITS SOFTWARE ENGINEERING INSTITUTE IS FURNISHED ON AN "AS-IS" BASIS. CARNEGIE MELLON UNIVERSITY MAKES NO WARRANTIES OF ANY KIND, EITHER EXPRESSED OR IMPLIED, AS TO ANY MATTER INCLUDING, BUT NOT LIMITED TO, WARRANTY OF FITNESS FOR PURPOSE OR MERCHANTABILITY, EXCLUSIVITY, OR RESULTS OBTAINED FROM USE OF THE MATERIAL. CARNEGIE MELLON UNIVERSITY DOES NOT MAKE ANY WARRANTY OF ANY KIND WITH RESPECT TO FREEDOM FROM PATENT, TRADEMARK, OR COPYRIGHT INFRINGEMENT.

Use of any trademarks in this presentation is not intended in any way to infringe on the rights of the trademark holder.

This Presentation may be reproduced in its entirety, without modification, and freely distributed in written or electronic form without requesting formal permission. Permission is required for any other use. Requests for permission should be directed to the Software Engineering Institute at permission@sei.cmu.edu.

This work was created in the performance of Federal Government Contract Number FA8721-05-C-0003 with Carnegie Mellon University for the operation of the Software Engineering Institute, a federally funded research and development center. The Government of the United States has a royalty-free government-purpose license to use, duplicate, or disclose the work, in whole or in part and in any manner, and to have or permit others to do so, for government purposes pursuant to the copyright license under the clause at 252.227-7013.



Report Documentation Page

Form Approved
OMB No. 0704-0188

Public reporting burden for the collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to a penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.

1. REPORT DATE MAY 2009		2. REPORT TYPE		3. DATES COVERED 00-00-2009 to 00-00-2009	
4. TITLE AND SUBTITLE The Impact of Conducting ATAM Evaluations on Army Programs				5a. CONTRACT NUMBER	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S)				5d. PROJECT NUMBER	
				5e. TASK NUMBER	
				5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Carnegie Mellon University, Software Engineering Institute, Pittsburgh, PA, 15213				8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)				10. SPONSOR/MONITOR'S ACRONYM(S)	
				11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release; distribution unlimited					
13. SUPPLEMENTARY NOTES presented at Software Engineering Institute (SEI) Architecture Technology User Network (SATURN) Conference, 4-7 May 2009, Pittsburgh, PA.					
14. ABSTRACT					
15. SUBJECT TERMS					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT Same as Report (SAR)	18. NUMBER OF PAGES 9	19a. NAME OF RESPONSIBLE PERSON
a. REPORT unclassified	b. ABSTRACT unclassified	c. THIS PAGE unclassified			

Objective of This Study

The Army Strategic Software Improvement Program (ASSIP) is a multiyear effort targeted at improving the way in which the Army acquires software-intensive systems.

As part of the ASSIP, the Army funded the Carnegie Mellon® Software Engineering Institute (SEI) to conduct software architecture evaluations using the SEI Architecture Tradeoff Analysis Method® (ATAM®). When a system's architecture did not exist or was not ready to evaluate, the Army sponsored SEI Quality Attribute Workshops (QAWs). Other Army programs funded their own ATAM evaluations and QAWs.

The objective of this study¹ was to determine the value the Army programs received from using the ATAM and the QAW.

This impact data will enable the Army to decide whether these practices should be considered for broad adoption across the Army.

1. Nord, R.L., Bergey, J., Blanchette, Jr., S. Klein, M. *Impact of Army Architecture Evaluations* (CMU/SEI-2009-SR-007). Software Engineering Institute, Carnegie Mellon University, 2009.



Army Programs

12 Army programs conducted 11 ATAMs and 5 QAWs from 2002 through 2007.

Army Programs (in alphabetical order)	ATAM	QAW
Aerial Common Sensor (ACS)	✓	✓
Army Battle Command System (ABCS)		✓
Command Post of the Future (CPoF)	✓	
Common Avionics Architecture System (CAAS)	✓	
Distributed Common Ground Station – Army (DCGS-A)	✓	✓
Force XXI Battle Command, Brigade-and-Below (FBCB2)	✓	
Future Combat Systems (FCS)	✓	✓
Integrated Fired Control (IFC)	✓	✓
Joint Tactical Common Operational Picture Workstation (JTCW)	✓	
Manned/Unmanned Common Architecture Program (MCAP)	✓	
One Semi-Automated Forces (OneSAF)	✓	
Warfighter Information Network – Tactical (WIN-T)	✓	



ATAM and QAW

ATAM Conceptual Flow

The purpose of the ATAM is to assess the consequences of architectural decisions in light of quality attribute requirements and business goals. The ATAM helps stakeholders ask the right questions to discover architectural risks.

The QAW is a facilitated method that engages system stakeholders early in the life cycle to discover the driving quality attributes of a software-intensive system.

Barbacci, M., Ellison, R., Lattanze, A., Stafford, J., Weinstock, C., & Wood, W. *Quality Attribute Workshops, 3rd Edition* (CMU/SEI-2003-TR-016, ADA418428). Software Engineering Institute, Carnegie Mellon University, 2003.

Clements, P., Kazman, R., & Klein, M. *Evaluating Software Architectures: Methods and Case Studies*. Addison-Wesley, 2002.

Software Engineering Institute | CarnegieMellon

Impact of Conducting ATAM Evaluations Nord, May 2009
© 2009 Carnegie Mellon University

5

Assessing Impact

Measurement Category	Comments
Inputs/Indicators	Measures inputs into meetings including the number of meetings, attendees, audience, costs, and efficiencies
Reaction and Perceived Value	Measures reaction to, and satisfaction with, the experience, ambiance, contents, and value of meeting
Learning	Measures what participants learned in the meeting-information, knowledge, skills, and contacts (takeaways)
Application and Implementation	Measures progress after the meeting-the use of information, knowledge, skills, and contacts
Impact and Consequences	Measures changes in business impact variables such as output, quality, time, and cost-linked to the meeting
ROI	Compares the monetary benefits of the business impact measures to the costs of the meeting

Phillips, J.J.; Breining, M.T.; Phillips, P.P. Return on Investment in Meetings & Events. Elsevier, 2008.

Software Engineering Institute | CarnegieMellon

Impact of Conducting ATAM Evaluations Nord, May 2009
© 2009 Carnegie Mellon University

6

Criteria for Evaluating Impact of ATAM/QAW

Quality Improvements	ATAM/QAW Preparation and Execution	ATAM/QAW Post-Engagement Activities
Programmatic (Cost and Schedule)	Effective in terms of <ul style="list-style-type: none"> • cost • effort 	Improved <ul style="list-style-type: none"> • program schedule performance • program cost performance
Product (System and Software)	Clarification, discovery, and use of <ul style="list-style-type: none"> • quality attribute requirements • architecture documentation • risks and risk themes 	Improved <ul style="list-style-type: none"> • software architecture • system qualities/capabilities • warfighter effectiveness
Practices (Acquisition and Development)	Foster communication among program office, suppliers, and stakeholders to <ul style="list-style-type: none"> • understand and control cost and schedule • communicate quality attribute requirements • evaluate the architecture • improve the architecture 	Organizational changes <ul style="list-style-type: none"> • use of the results • use of the practices in the short term • adoption of the concepts • adoption of the methods • training personnel to conduct the methods

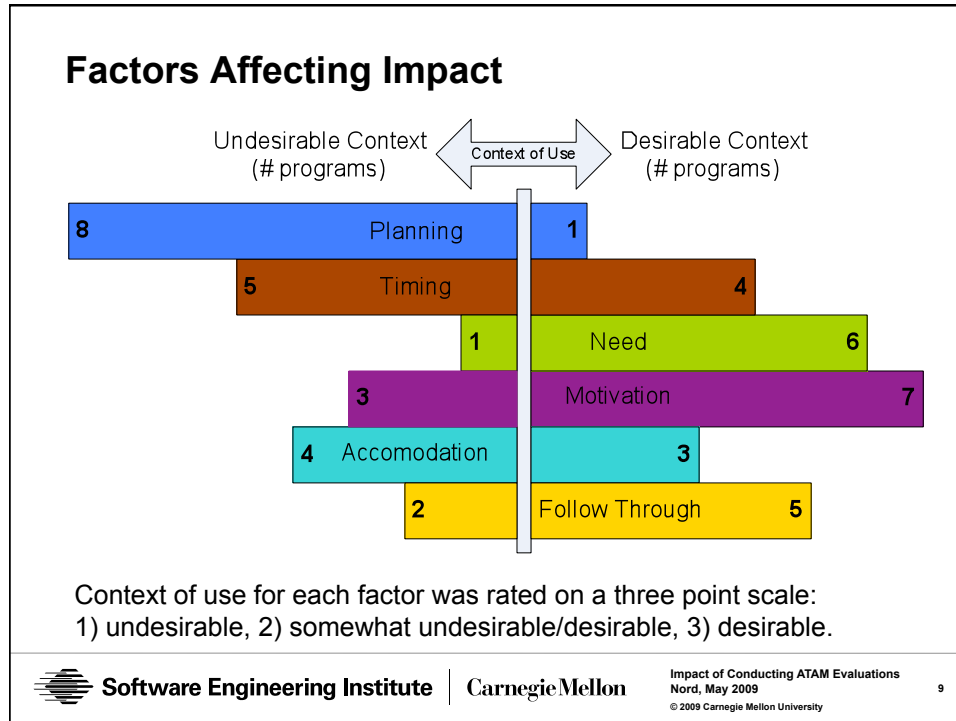


Questionnaire

The questionnaire was organized into four sections:

1. *Conducting the ATAM/QAW* - elicited information about product and practice improvements during preparation and execution of the method.
2. *Follow-On ATAM/QAW Activities* - elicited information about practice improvements during the post activities, focusing on how the engagement affected the immediate behavior of the organization.
3. *Adoption of ATAM/QAW* - elicited information about practice improvements during the post activities, focusing on how the engagement affected the long-term acquisition practices.
4. *Overall Impact* - elicited information about short-term and long-term programmatic improvements and long-term product improvements; in addition, it provided survey respondents an opportunity to share comments on how they perceived the overall impact.





Overview of Results - 1

Overall, the survey results suggest that the Army programs received benefit from the use of the ATAM and QAW. Context of use had a significant impact on these findings, leading us to believe that under appropriate acquisition conditions these practices are very likely to have a positive impact on system quality.

- Six of the 12 programs reported that it cost less to use the ATAM/ QAW than the techniques they traditionally have used. Moreover, they all reported results that were at least as good, and often better, than the results they traditionally obtained.
- Ten of the 12 programs reported that the ATAM/QAW provided an informed basis for the program office and the supplier to better understand and control the software development cost and schedule.

Overview of Results - 2

- All programs found that using the ATAM /QAW increased their understanding of the system’s quality attribute requirements, design decisions, and risks.
- Overall, the programs felt that the use of the ATAM/QAW provided a good mechanism for the program office, suppliers, and stakeholders to communicate their needs and understand how they are met.
- A majority of the respondents felt that using the ATAM/QAW led to an improved architecture (8 of 12), and a higher quality system (6 of 10). A minority of the respondents felt that using the ATAM/QAW would result in overall cost and schedule reductions for their respective programs.



Programmatic Improvements

Conducting the method	Better (or same)	Lesser
Cheaper (or same)	6	1
Costlier	4	0

Quality of ATAM/QAW Outputs vs. Other Techniques
(shown as number of programs)

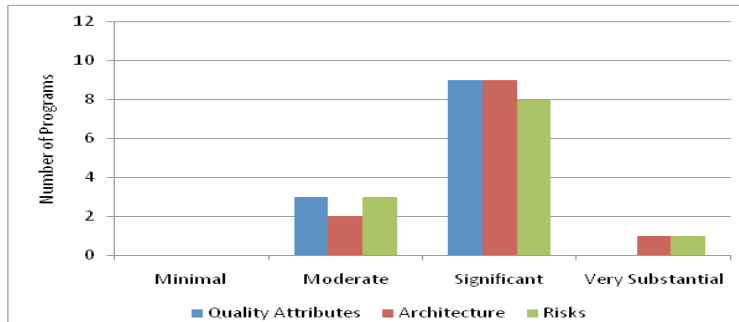
Overall, the data shows that the ATAM and QAW are effective techniques for eliciting quality attribute requirements and analyzing software architecture; in some cases, they are more cost-effective than traditional analysis methods.

In the other cases, people reported context of use affected their response and that they would use the methods in the future

- *“QAW and ATAM provided benefits deemed substantial enough to warrant adoption for future contracts.”*



Product Improvements

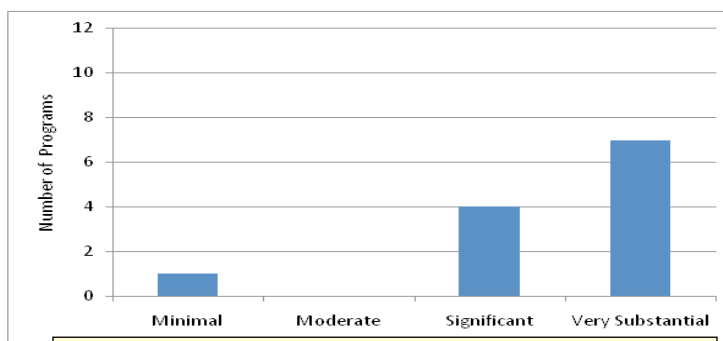


**Architecturally Significant Artifacts Enhanced by ATAM/QAW
(total number of programs is 12)**

These results demonstrate that the architecture team is able to use ATAM/QAW to achieve an understanding of stakeholder expectations for the system, the implications of architectural decisions on user needs, and the relevant risks to success.



Practice Improvements



**Communication Enhanced by ATAM/QAW
(total number of programs is 12)**

The significance of these results is that stakeholders, collectively, are able to use ATAM/QAW to achieve a common understanding of the system under development, making it more likely that the completed product will address stakeholder expectations and user needs, thereby improving chances for program success.



Transition

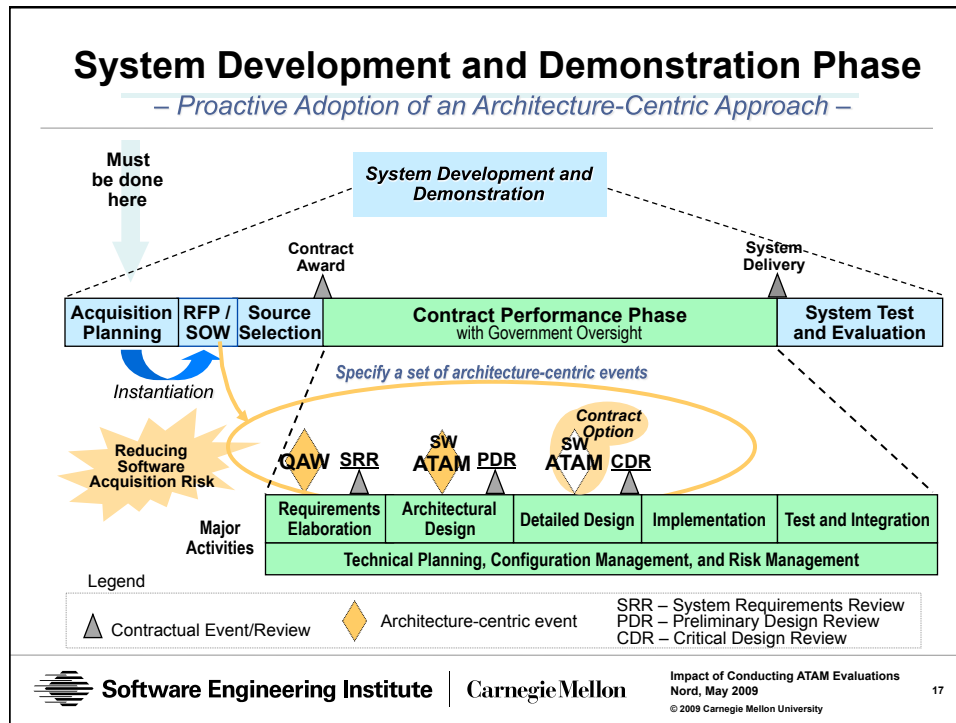
1. **All programs reported some use of the artifacts produced by the ATAM/QAW.** For example, some put the quality attribute scenarios they developed into a requirements tracking system, others improved their architecture documentation, and others formally tracked risks discovered during the evaluation.
2. **Eleven programs reported using the techniques** of the ATAM/QAW to uncover additional risks by, for example, refining or analyzing additional scenarios.
3. **Nine programs reported adopting the concepts** of quality attribute requirements elicitation and architecture evaluation.
4. **Seven programs reported adopting the ATAM/QAW methods** (i.e., by using or specifying the use of the practices).
5. **Three programs reported investment in formal ATAM training.**



Conclusion

The data gathered for this study confirms that the use of ATAM evaluations and QAWs are generally beneficial to DoD system acquisitions and suggests that maximal benefit is achievable only if architecture-centric practices are pre-planned and built into the acquisition process.





Contact Information

Presenter

Robert L. Nord
 Research, Technology, and System Solutions Program
 Telephone: +1 412-268-1705
 Email: rn@sei.cmu.edu

U.S. mail:

Software Engineering Institute
 4500 Fifth Avenue
 Pittsburgh, PA 15213-2612
 USA

World Wide Web:

www.sei.cmu.edu
www.sei.cmu.edu/contact.html

Customer Relations

Email: customer-relations@sei.cmu.edu
 Telephone: +1 412-268-5800
SEI Phone: +1 412-268-5800
SEI Fax: +1 412-268-6257