2-27-2013

Observations on Expedited Systems Engineering Practices in Military Rapid Development Projects

Debra F. Lepore
Stevens Institute of Technology

John M. Colombi
Air Force Institute of Technology

Jennifer Ford

Ryan Colburn

Yosef Morris

Available online at www.sciencedirect.com

SciVerse ScienceDirect

Procedia Computer Science 16 (2013) 502 – 511

Procedia Computer Science

Conference on Systems Engineering Research (CSER'13)
Eds.: C.J.J. Paredis, C. Bishop, D. Bodner, Georgia Institute of Technology, Atlanta, GA, March 19-22, 2013.

Observations on Expedited Systems Engineering Practices in Military Rapid Development Projects

Debra Facktor Lepore[a*], John M. Colombi[b], Jennifer Ford[b], Ryan Colburn[b], Yosef Morris[b]

[a]*Stevens Institute of Technology, Castle Point on Hudson, Hoboken, NJ 07030, USA*
[b]*Air Force Institute of Technology, 2950 Hobson Way, WPAFB, 45433, USA*

Abstract

This research, conducted in the Systems Engineering Research Center (SERC), examined systems engineering and engineering management practices for military rapid capability and urgent needs programs. Lifecycle of urgent needs programs is driven by "time to market" as opposed to complete satisfaction of static requirements, with delivery expected in months versus years/decades. The processes and practices applied to urgent needs must add value and not require an excessive bureaucratic oversight to implement, while at the same time address, understand, and manage risk such that programs can understand better where to include, truncate, eliminate, tailor, or scale systems engineering practices and processes. Focusing on aspects of the product, process, and people of military rapid organizations, the analysis showed that these organizations have the right team, develop innovative conceptual solutions, quickly prune the design space, and identify appropriate designs that can deliver warfighting capability expeditiously. While these observations may not seem new, they provide the foundation for a broader framework of rapid development, which is the subject of ongoing research.

Keywords: Systems Engineering, Rapid Acquisition, Business Agility, Acquisition Best Practices, Grounded Theory

1. Introduction

This paper identifies a set of 11 observations common to rapid acquisition and expedited engineering programs utilizing grounded theory and qualitative research methodologies. To accomplish this goal, the research team conducted site visits to over 30 organizations from across the U.S. Department of Defense (DoD) and the defense industry that focused on less traditional acquisition approaches such as rapid prototyping, mature technology integration, or platform modification. A set of 34 questions grouped by a loose taxonomy of people, product, and process was used to guide open discussions with these subject matter experts (SME). The responses from the site visits were analyzed for trends. The observations that emerged addressed systems engineering and engineering management practices in rapid development organizations. While these observations may not seem new, they provide the foundation for a broader framework of rapid development, which is the subject of ongoing research.

* Debra Facktor Lepore Tel.: +1-201-216-8103
E-mail address: Debra.Lepore@stevens.edu

doi:10.1016/j.procs.2013.01.053

While rapid acquisition offices often have unique attributes and permissions, yet the practices observed may be applicable to traditional acquisition programs of record.

This research has roots in the "Rapid Capability Fielding Toolbox" 60-day study conducted by the Department of Defense Research and Engineering Enterprise (DDR&E) and released in March 2010[1]. This study noted that the standard Department of Defense acquisition process is not designed to respond to the dynamic environment of rapid needs, and called for further investigation. Several Defense reports have documented in-depth studies on the problems and possible solutions surrounding rapid acquisition, rapid fielding and/or rapid prototyping[1,2]. Recommendations include acquisition process changes and introduction of new Systems Engineering tools designed to handle a rapidly changing environment.

The Defense Science Board (DSB) Task Force on the Fulfillment of Urgent Operational Needs[3] identified more than 20 rapid-reaction programs and organizations addressing DoD urgent warfighter needs. A subsequent DSB study found that urgent needs programs spent more than $50 billion between 2005-2009, and that urgent needs should be considered a critical, ongoing DoD institutional capability. In other words, "urgent" is becoming the new "normal." In March 2011[4], the GAO report, "DoD's Urgent Needs Processes Need a More Comprehensive Approach and Evaluation for Potential Consolidation," found that DoD has taken steps to improve fulfilment of urgent needs, but requires a common approach for addressing urgent needs. This report documents at least 31 entities that manage urgent needs and expedite the solutions to address them. We consider a problem is the lack of a framework that captures best practices across these rapid acquisition organizations and analyzes and relates them to other systems literature. The subject of our ongoing research is to establish this framework and also investigate how it could be applied to more traditional programs.

First, most define "rapid" as generally delivering a capability as quickly as 2 months and no longer than 24 months[4]. However we have also seen "rapid" referred to as "half the time of traditional acquisition". It will be important to further define "expedited" in relation to more traditional or deliberate acquisitions. More importantly, the characteristics of the fielded capability must be incorporated in the definition, such as amount of operational capability/performance, warfighter satisfaction, safety of operations, manufacturability, and sustainability (repairs, parts, etc). Naturally, many other design considerations may be critical, which must be balanced with time to market. We refer to "expedited systems engineering" as the set of systems engineering and engineering management activities used during a rapid acquisition, which may be tailored and scaled appropriately (or unfortunately eliminated or delayed inappropriately). This last approach has been termed technical debt[5].

This paper collects the observations made from the visits with subject matter experts at organizations practicing rapid development.

2. Methodology

Lane et al. 2010[6] examined critical success factors of five different organizations developing rapid, innovative solution and concluded that successful, high performance organizations share certain characteristics in the development of innovative systems. They concluded that successful, high performance organizations share certain characteristics in the development of innovative systems:

- Driven by business value
- Take calculated risks
- Proactive management and small agile teams
- Look for solution patterns that can be re-used
- Follow concurrent engineering practices
- Provide culture and environment that supports innovation.

These findings parallel Kelly Johnson's[7] famous "14 Rules of Management" developed in the Lockheed Martin Skunk Works program, where his motto was "Be quick, be quiet, and be on time."

The questions posed by Lane et al and other research[8] became the starting point for the lines of inquiry to the rapid organizations in our study. The expedited SE research used these basic factors as a guide and created a new list of 34 questions to go into the next level of detail of "why" or "how" a characteristic may be important. This list of questions guided open discussions, and did not specifically force closed responses to each question. Within the first week of interviews, obvious patterns began to emerge from the interviews. These patterns were clustered into 4 major categories: product, process, people, and project.

The organizations included 4 Systems-related Conferences (attendees and fellow panel members), 14 Rapid/ Defense Acquisition Offices,[9,10] 3 Defense Laboratories, 3 International/ US Defense Contractors, a Defense

Innovation Lab, and 2 smaller/entrepreneurial companies, 3 non-DoD Federal Program offices, 1 Academic Research Institute and 1 Federally Funded Research and Development Center.

The method used in this research is based on grounded theory. Grounded theory is a type of qualitative research methodology that allows theories to emerge from collected data. This collection of data comes from notes during discussions with the leadership of the "rapid" organizations—essentially experts in the field—to discern what made them successful and discover what drove their processes. The research follows a systematic, yet flexible process to collect data, code and analyze the data, make connections, and see what theories can be generated. This "open coding" of labels is an important part of the analysis concerned with identifying, naming or labelling, categorizing, and describing phenomena found in the discussion notes. In this case, the theory is a set of principles for successful DoD rapid acquisition.

Using the interview notes, an iterative qualitative analysis was performed using ATLAS.ti™ software in an effort to further explore the data for hidden connections and emergent trends. Transcribed notes from organizations were assigned to an ATLAS.ti hermeneutic unit. Using the observations derived through the interview process as codes, each document was coded appropriately against key words and phrases. The codes were organized into families of Product, Process, and People, which matched the clusters observed from the discussions. Originally 20 observations were first identified, aggregated down to 11.

3. Analysis

The following are the set of observations, summarized below, that have been used to expedite system development following the methodology, based on coding comments from the SME discussions from rapid Aerospace and Defense organizations. The major finding of this work is that Rapid acquisition in DoD requires an integrated approach: *People* making judgments, *Processes* for task/work reduction, and *Product* aspects focused on rapid objectives.

1. Use Mature Technology – Focus on the State of the Possible
2. Incremental Deployment (Development) is Part of the Product Plan
3. Strive for a Defined Set of Stable Requirements Focused on Warfighter Needs
4. Work to Exploit Maximum Flexibility Allowed
5. Designing out All Risk Takes Forever…Accept Some Risk
6. Keep an Eye on "Normalization"
7. Build and Maintain Trust
8. Populate Your Team with Specific Skills and Experience
9. Maintain High Levels of Motivation and Expectations
10. The Government Team Leads the Way
11. Right-size the Program - Eliminate or Reduce Major Program Oversight

In the current program management and lean product development communities, indeed, many of these have been observed in the literature[11,12]. Similarly, for those who practice DoD acquisition in some niche areas (laboratory or operational prototyping, classified acquisition or platform modification shops), these may also be commonplace. This list provides the foundation for a framework which may be applicable to more than rapid organizations. Future research leaves more to discover what further makes rapid organizations different than traditional and how can the rapid practices be transferred to traditional development.

3.1 Product Observations

Observation 1: Use Mature Technology – Focus on the State of the Possible

In rapid acquisition, untested and unproven technology poses an enormous risk to system success. To avoid this pitfall, most rapid programs focus engineering efforts on the interfaces required to blend multiple existing technologies into a system capable of providing the desired set of capabilities. Another aspect of rapid is modifying an existing platform or simply adding subsystems and components. By leveraging existing components and integrating them in a new or innovative way, a laboratory organization may be able to provide an equivalent or interim solution in short order. In this environment, the warfighter is given something to use now, and as technology matures, they can expect greater capability in the future. While we observed that schedule demands often resulted in technologically mature solutions, the use of immature or state-of-the-art technologies would be

appropriate when no other concept exists, or time urgency can be relaxed. Essentially, choice of mature technology is yet another decision that should be approached through a balanced risk management process.

Observation 2: Incremental Deployment (Development) is Part of the Product Plan

Part of the agreement of accepting a partial solution may also include the plan for incremental development. When this concept is decided upon from the beginning of any development program, it enables "generational development" – an intentional plan for technology maturity, advancement, and cycles of growth. This may be done by using open architectures and modular concepts, clearly defining system interfaces, and utilizing industry standards. When planning for incremental growth in platform capabilities from the start, particular systems level planning is put into place. This approach allows known or unknown technical improvements to be more easily integrated into the baseline system—providing faster upgrading and an enhanced ability to share system level data. Overall, this approach will extend the system lifecycle and enhance its ability to flexibly meet the needs of an ever-changing technical and operational environment.

3.2 Process Observations

By first focusing on validating requirements, rapid organization then exploited and executed their programs with the greatest flexibility allowed.

Observation 3: Strive Toward a Defined Set of Stable, Tailored Requirements Focused on Warfighter Needs

Defining stable requirements focused on the customer needs was one of the most frequently occurring principles during the SME discussions. It quickly became evident that every one of these organizations spends a significant amount of time up-front, face-to-face with their customer discussing the actual need, the operational context of the need, and the subsequent requirements to meet that need in the fastest time possible. Equally important is an effort to keep the requirements stable. Regardless of the scope of a project, requirements creep will negatively impact the timeline of a project, delaying the delivery of operational capabilities to the warfighter. Further, requirement changes potentially weaken the scope of the project or may negate any perceived increase in baseline capability.

As a tenant for rapid SE, stabilizing requirements starts with ensuring the requirements are right. Rapid organizations validate requirements early and often with the customer to determine needs based on capabilities, rather then satisfying all-inclusive wants. The acquiring organization must be willing to push back against unfeasible requirements, or schedule impacting requirements, in the interest of time. This is reflected in an active negotiation with the warfighter to make trades to establish requirements that are possible in the desired timeframe and with the budget available.

The short duration of rapid acquisition projects naturally lends to more stability in requirements. Grand changes in technical maturity or capability are not often experienced in the lifecycle of the project. Second, there are fewer changes in political administration (funding), leadership (rotating Colonels), and program personnel; each personality brings to the project a new perspective or priority than their predecessor. Finally, the requirements stemming directly from urgent warfighter needs are less likely to change over the short period of time. The process to eliminate, modify, or scale certain requirements – with a focus on capability delivered – provides the warfighter with a viable solution to a problem within an expedited, achievable timeline rather than a never-ending, expensive pursuit of the 100% solution in a longer timeframe, by which time the urgent need will have expired anyway.

Observation 4: Work to Exploit Maximum Flexibility Allowed

It may appear to the casual viewer that these rapid organizations are the “Wild West” of the DoD acquisitions community. However, solid acquisition and systems engineering approaches to solving complex technical problems and fulfilling real operational needs were consistently observed. Because of the specialized nature of each rapid organization, many have developed in-house processes adaptable to each new program. This ensures each program office has a specific roadmap leading it to success, and each project lives within its own specific process and lifespan. Anything not required, deemed unnecessary, or found to be non-value added is set aside. These organizations do this by understanding, leveraging, and utilizing the maximum flexibility in existing acquisition regulation and policy, applying the intent of the DoDI5000.02 process, without excess. It may also appear these organizations are skipping steps in the acquisition process. The research indicates these steps are not skipped, but rather tailored or scaled to meet the stringent timelines required to deliver product to the warfighter. For example, a Systems Engineering Plan (SEP) may consist of only two pages within a higher level document, instead of a 30-

page stand-alone file. The organizations make use of flexible contracting and management methods, such as formal and informal review processes and milestone-type reviews, with the right people in attendance to make go/no-go decisions on the spot. The focus is to document important technical and programmatic information and critical decisions. There are no documents produced for documentation sake.

In talking with some organizations, it became evident their approval chain for reviews and program milestone approval had been shortened, and the approval chains were clearly defined. In most of these organizations, there are very few extraneous persons in the review chain that do not have some sort of approval authority or intrinsic value added (such as legal or contracting). The brevity of these approval chains often stems from a Program Management Directive (PMD) outlining the decision-making authority within these organizations. This document can outline specific positions with approval authority, typically pushing it down to a lower level of responsibility within the organization, shortening the approval chain and reducing the time required to make programmatic decisions. Some of this brevity may also stem from the classification level of the project, literally preventing some personnel from participating. Program size also may keep budgets under Major Defense Acquisition Program (MDAP) thresholds.

Observation 5: Designing out All Risk Takes Forever – Accept Some Risk

Rapid organizations operate under an uncommon risk paradigm when compared to many large DoD acquisition programs. In rapid, the potential for "failure" through providing only a partial or short term solution to the field may be acceptable to the warfighter, as this may be preferable to delivering nothing at all. These teams are made up of experienced technical experts who cognitively assess the availability and risks of different technical solutions throughout the design process, sometimes with formal risk assessment processes in place. This idea of risk mitigation through use of mature and proven technology led several programs to adopt the concept of demonstrations or prototyping versus modeling as a better use of time and resources. The bottom line often came down to the level of program or technical risk the customer is willing to accept—emanating from detailed conversations with the customer. If the warfighter could utilize a partial solution and is willing to take some technical risks with a prototype in the field, delivery times are considerably shortened and feasible solutions can be arrived at allowing testing in the field and real-world feedback for incremental improvements.

While thinking creatively is not necessarily commonplace in everyday acquisition, in rapid acquisition it is absolutely acceptable and quite often critical to success. Creative and implementable solutions must be sought in order to do things rapidly. Some of this success hinges on expert understanding of the design space, potential technical solutions, and the ability to integrate existing technologies. Rapid programs work through a rigorous design process to identify, eliminate, and accept risks. However, attempting to design-out all risk is a time consuming and costly process, and not realistic if attempting to get a solution out to the customer quickly.

Observation 6: Keep an Eye on "Normalization"

"Normalization" is a term heard at one of the larger DoD rapid acquisition offices, but the concept was introduced early in the research definition phase and was reoccurring. It describes the transition of a program from a prototype or rapid project into a major (mainstream) acquisition program (also known as a "program of record"). Most rapid organizations stated they typically work in prototyping or small-rate production runs (a few to less than 15). Thus, the investments required for product implementation are minimal compared with a large aircraft program predestined for a full rate production phase and years of sustainment. However, as many rapid projects have the potential to become normalized or productized, it is advantageous for these offices to keep their eyes on this possibility and be prepared for a full-scale transition. Effectively, this term relates to a program that was originally schedule-driven, but has been asked to become lifecycle-optimized.

3.3 People Observations

The rapid organizations provided many comments on trust, strong team skills, empowered leadership and a unique culture with high expectations of the team.

Observation 7: Build and Maintain Trust

Building and maintaining trust enables empowered teams that are able and allowed to make decisions, with leaders standing behind their decisions, and the team dealing with success or failures as they are encountered. The scope of trust is an important element for expeditious behavior and extends throughout the organizations in acquisition, development and deployment, and particularly in the interfaces between these three. As noted by P.

Lencioni[13] and others, trust is the critical foundation of teamwork without which it is not possible to effectively team or collaborate. Trust becomes ever more important amongst the parties at higher levels of decision making.

Comments repeatedly showed leadership at all levels providing top cover to allow teams to focus on executing the mission. These same leaders must be empowered and trusted at the lowest level possible to make tactical and strategic decisions. When decision making authority is placed at a low level it shortens the process, reduces opportunity for stall time, and fosters close relationships. "Low level" was observed to be the lowest level at which existed sufficient information and knowledge upon which to base a decision.

Trust is built through expertise (the depth and breadth of experiences) and record of performance. On the outside, it appears relationships exist on an organizational level. However, building and maintaining trust within a program team required constant nurturing. Trusting relationships showed just as important between individuals within these teams as building and maintaining trust with customers and senior leaders. It was consistently observed that personal trust relationships at every level built foundations for organization reputation and credibility. The existence of a trust network appeared important for developing connections inside and outside the organizations.

Observation 8: Populate Your Team with Specific Skills and Experience

Data indicated to hand picking teams and developing specific skill sets as a key aspect of success, with over 90% of the organizations indicating they handpicked their staff. Organizations identified required skills needed for each project and took necessary actions to acquire that skill set. Several methods of acquiring these skill sets were used: handpick new individuals, grow/groom current personnel, hire contractor support, and reorganize teams. For these organizations, these vital individuals, either of their own accord or external grooming, become experts with very specific skill sets and experiences, including the context of an entire acquisition cycle in an expedited manner. In some cases, a person with the right attitude, personality, or motivation can make up for a lack of technical skill or experience – especially when combined with mentoring or working alongside those with more experience. This allowed these organizations to strategically leverage the strengths of the personnel they had—even if that meant moving personnel as projects progressed. These individuals can then apply their skill sets to projects with specific customers, technologies or operational contexts.

A vital trait of aggressive DoD acquisition involves acute proficiency and depth concerning the application of the so-called "normal" acquisition process. In order to tailor or scale the applicable rules of acquisition and engineering, team members must first understand what the rules are and which rules or processes apply to the situation. People with deep roots and experience in acquisitions, contracting, finance and engineering know what the standard processes are. They have executed large and small projects using various methods and standards and understand the risks and how to manage the risks. Thus, they are keenly aware of the implications from omitting a step, tailoring or combining steps, or in executing parallel development processes. Their expert knowledge of the proper process allows them to create a process specifically designed to meet the needs of their program.

Observation 9: Maintain High Levels of Motivation and Expectations

During the site visits, the researchers observed a certain enthusiasm abounding in the leaders and personnel—seeming to share a state of mind that was somehow both traditionally military and entrepreneurial in spirit. The mindset of the organizations seemed to be expressed from a competitive nature born from a unique skill set, an aggressive and competitive environment, and a tangible connection to helping accomplish an operational mission. The organizations are motivated.

Through discussion, this motivation appears to emanate from three primary sources. First, there is a direct connection to an operational community. Working closely with the end users creates both a connection to the operational task at hand and puts a face on the customer. Second, there is a sense of urgency. JUONs by their nature are "urgent" and of critical importance. Providing capability to the field may very well be a matter of survival and mission success for US military members. Finally, the rapid nature of these projects provides a tangible result not typically experienced by members of the acquisition and engineering community. Members of the rapid acquisition community have the opportunity to see a project throughout an entire lifecycle, from concept definition, through development, and launch it into operational use. This concrete effect of seeing the fruits of labor utilized by its intended customer can be very powerful and help maintain sustained levels of motivation--even through long and arduous workdays.

A unique environmental characteristic observed in several organizations was one in which mistakes are OK, but not OK to be repeated. This concept is vital to fostering a creative, collaborative, and yet competitive environment. One specific technique observed to hone organizational skills is a "debrief culture". Originating from the

operational world of reviewing a mission, focused debriefs on team performance can be extremely powerful. A debrief culture emphasizes learning from mistakes and works to identify root causes (individual or organizational) to improve future endeavors. Furthermore, the debrief process may be applied to iterations or phases of current projects in addition to a final project debrief. The purpose of a focused debrief is to determine what went wrong and develop "lessons learned" (much like a detailed heuristic) to prevent the same errors from occurring in the next project or subsequent iterations of the current project.

Observation 10: The Government Team Leads the Way

Rapid DoD organizations work hard to find and hire military and government experts. Government personnel are expected to run the programs, often times without a prime contractor or support contractors as part of the government program management organization. Many of the rapid programs appeared to have a small support contractor footprint, if at all, compared to most major acquisition programs. This is not to say they did not employ or rely on contractors to provide leadership or technical support on a large or small scale. However, when programs did have a support contractor workforce, the expectation was still the same: The government engineer, program manager, operations representative, etc., was expected to be the resident expert on the program.

These government teams are typically comprised of a set of functional experts as a development team. Core capabilities will exist on these teams – a program acquisition officer, resource/financial manager, system engineer, operational expert, safety, and test personnel. Technical competence is the standard, not the exception. It is expected that every member of the team is technically able to run his or her portion of the program. Team members maintain awareness of activities and issues on all aspects of the development program, regardless of government or contractor responsibility. There is little room for redundancy.

Observation 11: Right-size the Program - Eliminate or Reduce Major Program Oversight

Budgets are often thought of as a process principle, but it depends on the context. One benefit many of the rapid program offices enjoy is a lack of size. When you are to move fast, smaller is often better. Not only do large organizations create challenges to effective management and full utilization of all personnel resources, they tend to have larger budgets. Big programs and big budgets can easily become targets for increased oversight, longer approval chains, and funding cuts. In this sense, being big creates its own problems. Size becomes its own enemy.

In this research, the size of the program budgets appeared directly related to the products themselves. The design and technologies selected to meet operational requirements directly impact the cost of the program. Sub-system product selection, interface complexity, sustainment considerations, and technical maturity all drive cost. Keep in mind these organizations are focusing on the "23-80%" solution, are not going into mass production, and are not necessarily planning for long-term sustainment. However, these organizations intentionally take steps to reduce the overall size of their budgets. For example, the willingness to accept some types of risk buys down the cost of the design, development and manufacturing efforts. Costs (and risk) are also reduced by using proven or mature technology. Utilizing simple or standard interfaces can help reduce complexity—reducing development costs.

3.4 Data Analysis

While the organizations in the data analysis create different products and use different processes, several common and noteworthy themes emerged from the data. During the qualitative software analysis, the 11 practices discussed previously were coded a total of 310 times against the transcribed notes. Figure 1 shows the number of times each specific practice was materially mentioned or cited as a significant or important business practice in the interviews.

The data presented in Figure 1 shows a dominant trend of the top five most common occurring practices of rapid organizations, based solely upon the initial qualitative coding analysis. The top five practices were found to be

1. Build and Maintain Trust
2. Defined Set of Stable Requirements focused on Warfighter Needs
3. Populate Your Team with Specific Skills and Experience
4. Maintain High Levels of Motivation and Expectations
5. Work to Exploit Maximum Flexibility Allowed

These five practices comprised more than two-thirds (64.2%) of the total citations made during the analysis, with 199 out of 310 total codes, and three of the top five originating in the People domain.

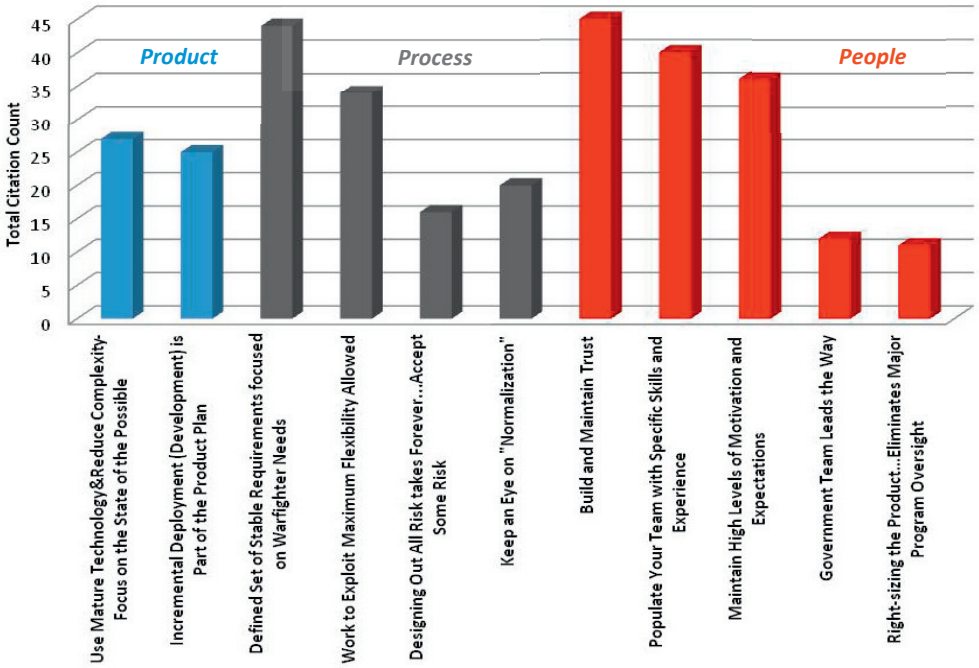

Figure 1: Total Practice Citation Counts from Discussions with Rapid Organizations

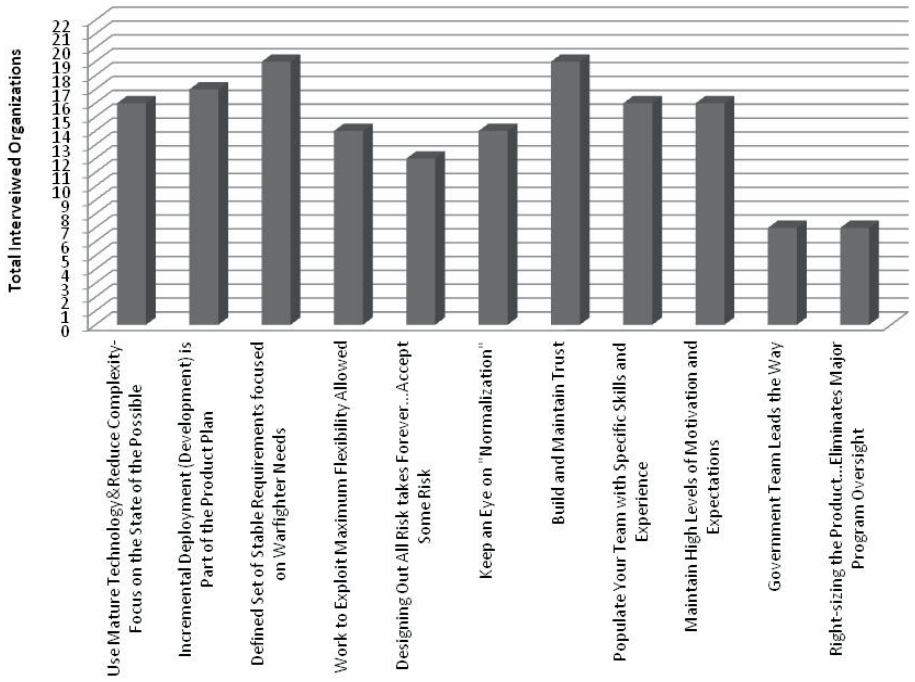

Figure 2: Number of Rapid Organizations Citing each Practice at least once

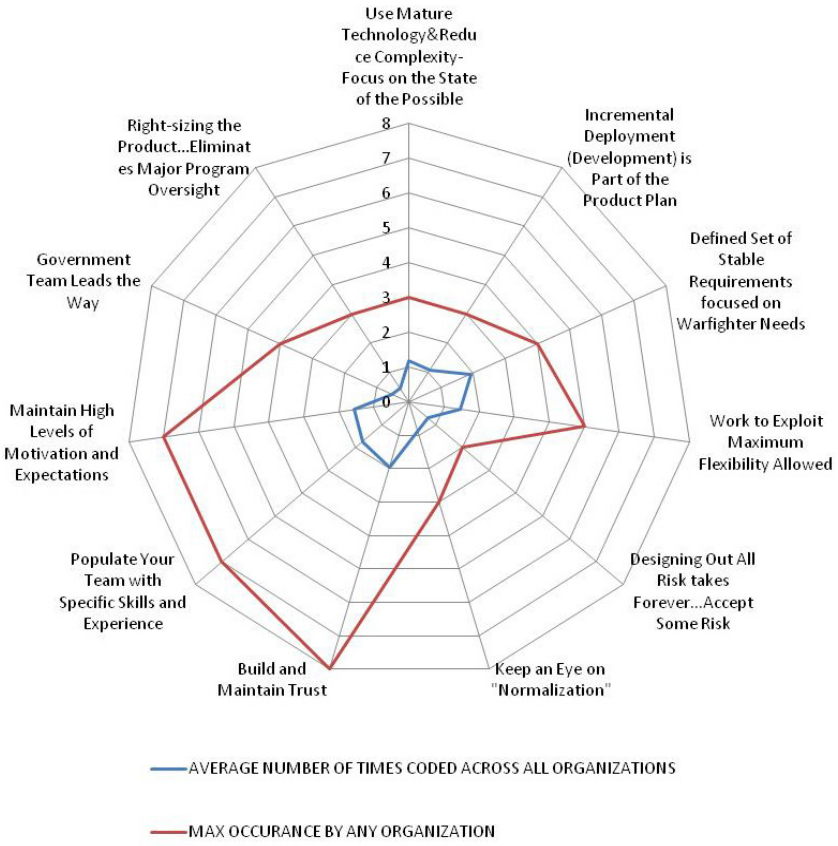

Figure 3: Average and Maximum Citings of Each Practice

The coding of practices to interview data did not result in every organization receiving a corresponding citation for each of the 11 practices. While many of the practices were noted in almost all the organizations, several practices were only prevalent in a small majority of organizations, and some organizations were noted as emphasizing or mentioning a specific practice multiple times, resulting in multiple codes against that practice. For comparison, Figure 2 shows the total number of organizations citing each practice at least once.

To further examine the occurrence of practices by each organization, the average occurrence of each practice across all organizations was examined. The two practices with the highest average occurrence (defined as the average time each organization was coded against that practice) are *Build and Maintain Trust* and *Defined Set of Stable Requirements focused on Warfighter Needs*; as expected based upon the top five occurring practices presented above, occurring on average twice in each organization. For contrast, Figure 3 shows the average number of times each practice was coded across all organizations and the maximum time each practice occurred in any organization.

4. Summary and Ongoing Research

This research is based on discussions with over 30 organizations conducting rapid development, primarily supporting military urgent warfighter needs. Analysis conducted shows a set of 11 observations common to organizations utilizing expedited systems engineering and engineering management practices. The observations show that rapid development requires an integrated approach: *People* making judgments, *Processes* for task/work reduction, and *Product* aspects focused on rapid objectives. These "3 P's" show organizations are mindful of their people and mindful of the requirements, and use iteration to field solutions quickly and refine those requirements. Lastly, the rapid organizations seek out flexibility in process, contracting and right-sizing the solution to avoid undue oversight.

While these observations may not seem new, they provide a foundation for a framework of expedited development. Ongoing research is conducting further analysis on these observations and the cultural environment that may distinguish rapid from traditional organizations. For example, additional observations in the new research address efficient information/knowledge sharing and the role of risk management in a culture. Rapid projects demonstrated both an exploitation of mature technologies and rapid solutions during their planning function, as well as the efficient and effective ability to execute those plans. This would reflect organizational ambidexterity. An additional new observation was that the people and process are highly dependent on the product, and vice versa. This ongoing research is focused on creating a "Framework for Expedited Systems Engineering for Rapid Capability and Urgent Needs" that reflects the observations, findings, analysis, and resulting recommendations. An opportunity included in this research is the possibility of taking the findings of this framework and applying them to a program not currently integrating all of the findings. This implementation of the framework could be used to analyze the framework by applying it to a DoD acquisition program and iterate it based on observations and results.

Rapid acquisition is exciting and rewarding. There is an enthusiasm that is infectious throughout the organizations that regularly practice "rapid" successfully, and we expect that culture can spread throughout the entire acquisition community.

Acknowledgement

This material is based upon work supported, in whole or in part, by the U.S. Department of Defense through the Systems Engineering Research Center (SERC) under Contract H98230-08-D-0171[14]. The SERC is a federally funded University Affiliated Research Center (UARC). Collaborators on this project include researchers from Stevens Institute of Technology, the Air Force Institute of Technology, and the University of Southern California. We graciously thank our sponsor and collaborators.

References

1. Office of the Under Secretary of Defense, DDR&E, Rapid Capability Fielding "Toolbox" study, Washington DC: OSD, 2012.
2. Office of the Under Secretary of Defense for Acquisition, Technology and Logistics, Using Prototyping to Support Rapid Fielding Efforts. Washington DC:OSD, 2011.
3. Office of the Under Secretary of Defense for Acquisition, Technology and Logistics, Fulfillment of Urgent Operational Needs. Washington DC: Report of the Defense Science Board, 2009.
4. United States Government Accountability Office (GAO), DOD's Urgent Needs Processes Need a More Comprehensive Approach and Evaluation for Potential Consolidation. GAO-11-273, 2011.
5. W. Cunningham, The WyCash portfolio management system, Experience Report. Proceedings on Object-oriented programming systems, languages, and applications (OOPSLA '92), 1992.
6. J.A. Lane, B. Boehm, M. Bolas, A.M. Madni & R. Turner, Critical success factors for rapid, innovative solutions. 4th International Conference on Software Processes, Paderborn, Germany, 2010.
7. C.K. Johnson. Kelly's 14 rules and practices. 2012. Retrieved, 2012, from http://www.lockheedmartin.com/us/aeronautics/skunkworks/14rules.html
8. D. Van Scoter, & T. Doolen. Comparative analysis of critical success factor research. Proceedings of Industrial Engineering Research Conference. 2011.
9. U.S. Army Prototype Integration Facility, Description, http://www.redstone.army.mil/amrdec/pif/index.html
10. Operationally Responsive Space (ORS), Mission. http://ors.csd.disa.mil/mission/index.html
11. J.M. Morgan & J.K. Liker. The Toyota Product Development System: Integrating People, Process And Technology. New York,NY: Productivity Press. 2006.
12. J. Oehmen, ed. The Guide to Lean Enablers for Managing Engineering Programs.Version 1.0. Joint MIT-PMI-INCOSE Community of Practice. May 2012.
13. P. Lencioni, The Five Dysfunctions of a Team: A Leadership Fable, 2002.
14. D.F. Lepore, J. Colombi et al, "Expedited Systems Engineering for Rapid Capability and Urgent Needs," Systems Engineering Research Center (SERC) Research Task (RT) #34, 2012. Unpublished.