SYM-AM-16-077

PROCEEDINGS
OF THE
THIRTEENTH ANNUAL ACQUISITION RESEARCH SYMPOSIUM

THURSDAY SESSIONS
VOLUME II

A Conceptual Framework for Adaptive Project Management in the Department of Defense

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Published April 30, 2016

Prepared for the Naval Postgraduate School, Monterey, CA 93943.

ACQUISITION RESEARCH PROGRAM
GRADUATE SCHOOL OF BUSINESS & PUBLIC POLICY
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The research presented in this report was supported by the Acquisition Research Program of the Graduate School of Business & Public Policy at the Naval Postgraduate School.

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Panel 22. Improving Project Management of Complex Systems

Thursday, May 5, 2016	
3:30 p.m. – 5:00 p.m.	**Chair: William Taylor, Col, USMC (Ret.),** Program Executive Officer Land Systems, Marine Corps ***A Conceptual Framework for Adaptive Project Management in the Department of Defense*** Martin Brown, Jr., Project Manager, Program Executive Office for Enterprise Information Systems ***Program Affordability Tradeoffs*** Brian Schmidt, Economic Analyst, The MITRE Corporation Josie Sterling, Economic/Business Analyst, The MITRE Corporation Patricia Salamone, Business and Investment Analyst, The MITRE Corporation Ginny Wydler, Principal Analyst, The MITRE Corporation ***Squaring the Project Management Circle: Updating the Cost, Schedule, and Performance Methodology*** Charles Pickar, Senior Lecturer, NPS

A Conceptual Framework for Adaptive Project Management in the Department of Defense

Martin Brown, Jr.—is an experienced Project Manager with over 30 years of delivering successful results. During his Air Force career, he managed the transition to Air Mobility Command and was part of the multi-service group who defined the Joint Operations Planning and Execution System (JOPES). After leaving the Air Force, Brown spent 25 years successfully managing advanced research and production system projects. He was often called upon to rescue troubled projects. Brown became a Navy civilian in 2009 as the IIPT Lead for the Maritime Domain Awareness initiative. He was the Acquisition Lead for the Distributed Common Ground System—Navy, Increment 2 prior to joining the Navy Enterprise Networks team and the Mobility Lead for the Navy Marine Corps Intranet (NMCI). Brown holds both the Project Management Professional (PMP) and Agile Certified Practitioner (ACP) certifications from the Project Management Institute as well as a Level 3 DIAWA certification in Program Management. He has published several research papers on topics such as command and control in an information rich environment and adopting agile concepts in the DoD.

Abstract

Over the past 60 years, the conceptual framework defining project management has remained relatively unchanged despite a consistently poor success rate. The prescriptive, plan-based process has withstood several challenges because logically, it should work. In the past 10 years, the subject of complexity has received considerable attention from researchers. At the same time, project management is receiving attention from a fresh perspective. In the past, research focused on attempting to understand the underlying reasons for poor results. That has turned around with recent research focusing on project management success. Research has uncovered a set of traits found in consistently successful project managers indicating that successful managers approach project planning and execution from a different perspective than is taught in traditional project management curriculums. These successful project managers are able to adapt and adjust during execution to keep the effort progressing. This adaptive style of project management consistently performs well for highly complex environments, but it requires a perspective accompanied by skills that are not usually taught in traditional project management training curriculums. The purpose of this paper is to identify the characteristics of an adaptive project management framework and outline how those skills can be taught in the DoD acquisition environment.

Introduction

This research examines complexity as it impacts project management within the Department of Defense (DoD). The objective is to identify and explore the applicability of concepts emerging from recent research on project complexity and project management under conditions of complexity. The paper begins with an overview of traditional, prescriptive, plan focused project management concepts. The paper then explores a number of challenges to the traditional approach with an expanded discussion on agile principles applicable to project management.

The third section of the paper explores the concept of project complexity and research into the concept and its impact on project management. Following the discussion of project complexity, the paper explores project management and recent research identifying attributes of project managers with consistent records of success under conditions of complexity. Then, based on these attributes and borrowing from research, it describes an adaptive project management approach designed to address complex project environments. Finally, this paper makes initial recommendations for future project management training and education focusing on the specific success factors.

Traditional Project Management

The project management profession traces its roots back to the 1950s and the post-war environment. Project management evolved as a plan centric, prescriptive process. The focus is on creating the project plan and then executing to the plan. Project management theory grew from the "Scientific Management" approach set forth by Frederick Taylor. Scientific Management proponents believed that any process could be decomposed into its fundamental tasks. The ability to study, model, plan and implement improved task performance was key for improving efficiency and increasing profits. The transformation model of production served as the basis for an evolving concept of project management focused on managing work. In the transformation model, raw materials are converted into valuable, finished products through the efficient application of resources (primarily work). Early project management thought leaders like Fayol (work breakdown structure) and Gantt (schedule work) established a core set of principles that went unchallenged until the start of the 21st century.

This belief that managing projects is about managing work has become institutionalized, with a number of project management products designed to assist in the work management process. Work is planned and then managed to that plan for maximum efficiency. This plan prescribes the amount of work required and, through a few simple calculations, the budget and time required to complete the project. This plan centric approach to project management is reflected in the Project Management Institute's *Project Management Body of Knowledge* (PMBOK). PMBOK identifies 47 project management processes (Project Management Institute, 2013), and the majority (24) are directly linked to the planning phase of the project. Additionally, execution and controlling processes compare execution to the plan and seek to return to that plan, adjusting only as a last resort and only under carefully planned and documented processes. This plan centric thinking also serves as the foundation for a number of project related products, training courses, and certifications, resulting in the concepts becoming institutionalized.

The problem is that application of the processes, techniques, tools and methodologies have not resulted in a consistent pattern of success. Research by the Standish Group indicates that overall success rates for traditional project management methods (32%) are no different than those for an ad-hoc approach (44%; Standish Group, 2010). The 2010 IT Project Success survey by Dr. Dobb's Journal found that ad-hoc projects were 49% successful, while traditional approaches were 47% successful. The Dr. Dobb's IT Project Success Survey looked at Incremental and Agile project methodologies as well. The survey indicates that these two methods do improve project success rates to approximately 60%, which means that 40% of all projects will continue to fail or face significant challenges. Within the DoD, the results have been comparable. A November 2015 report by the Government Accountability Office (GAO) found that "the Federal Government invests more than $80 billion annually in IT. However, these investments frequently fail, incur cost overruns and schedule slippages, or contribute little to mission related outcomes" (Power, 2015).

A challenge facing advocates of revised thinking about project management is that these concepts have become institutionalized. Both the PMI and the DoD offer professional certificates based on demonstrated knowledge and experience in traditional project management. A number of products exist to assist in traditional project planning by delivering greater precision, sometimes at the cost of accuracy and predictability. Agencies such as the Government Accountability Office, faced with evidence of project management problems, focus on recommendations to improve the rigor and discipline used to apply traditional methodologies rather than exploring alternatives. Alternative concepts such as

agile are re-cast are variations of the traditional approach. Because the plan centric concept has become institutionalized, many refuse to accept what the evidence tells us. Hill and Geras (2016), in their paper "System of Denial, Strategic Resistance to Military Innovation," found that "Dominant organizations have systems that focus organizational energy and attention on exploitation—that is, sustaining the status quo and continuing to improve what we already do." They go on to point out that this behavior inhibits continued learning and can generate "dysfunctional organizational responses to inconvenient information" (Hill & Geras, 2016). There have been improvements in DoD project performance in recent years, but innovative thought is constrained by conventional wisdom and organizational inertia.

Challenges to Conventional Wisdom

There have been challenges to this traditional view of project management, and there is no shortage of reasons proposed for the poor performance. Variations on the basic transformation have included the "Theory of Constraints" (Goldratt, 1997), a resurgence of the Flow model, originally proposed by Henry Ford and reintroduced as the Toyota (Ohno, 1988) way in the 1980s, and more recently a focus on value maximization as the basis of project management. In a briefing for International Project Management Day 2008, Harold Kerzner traces the evolution of views on Project Management. He found that traditional views of success being measured by the triple constraints (cost, schedule, scope) are giving way to a focus on delivering value within imposed constraints. This shift in thinking is significant in that it acknowledges that there is flexibility in the triple constraints that a knowledgeable project manager can use for business success.

Recently, the move toward agile methods further threatens traditional views of project management. Although many organizations focus on specific agile methodologies and rituals (e.g., short iterations, daily stand up, retrospectives) the heart of agile implementation is the fundamental changes to project management called for in the Agile Manifesto and the Agile Principles.

Agile practitioners see the detailed planning, task decomposition and assignment of hours at the start of a project as unnecessary, often wasted effort that sacrifices accuracy with the illusion of precision. Work, at the task level, is best assigned by the team performing the work as close as possible to the actual start of that work when the most information about the tasks is available. Scrum, the most popular agile method in the United States, eliminates the project management role, instead assigning typical project management responsibilities to various participants in the process.

The Project Management Institute (PMI) has had a difficult time adjusting to agile. Agile challenges several key tenets of the project management conceptual framework. First, agile welcomes change. The plan centric methodology of traditional project management maintains alignment with the plan until there is a compelling reason to change. Principle two states that change is welcome, stressing the need to be flexible unless there is a compelling reason to stay with the plan. Principles five and 11 stress the concept that quality and best value will emerge from the agile process during execution.

The PMI does offer a certification as an Agile Certified Practitioner (ACP), but this is based on agile work experience and a review of agile principles and survey of various agile methodologies. Michele Sigler, in the "Software Project Manager's Bridge to Agility," sees the logical transition from project manager to scrum master who serves as a facilitator to the software development process. In many ways, this is a return to the concept that managers manage work. But, is this the correct role for the project manager? Agile provides a separation of project and production responsibilities. The scrum master and the development team(s) are responsible for the production elements. They follow the rituals

and develop a predictable throughput, but this is independent of any specific project. The product owner in scrum is responsible for defining, prioritizing and accepting the individual features of the project being developed which is more in line with

the project manager responsibilities. The issue is that thought and concept development for agile methodologies has focused on the development process or production side of the equation.

Agile Principles

1. Our highest priority is to satisfy the customer with early and continuous delivery of valuable software
2. Welcome changing requirements, even late in development. Agile harnesses change for the customer's competitive advantage.
3. Deliver working software frequently, from a couple of weeks to a couple of months, with a preference for the shorter timescale.
4. Business people and developers must work together daily throughout the project.
5. Build projects around motivated people. Give them the environment and the support they need, and trust them to get the job done.
6. The most efficient and effective method of conveying information to or within the development team is face-to-face conversations.
7. Working software is the primary measure of progress.
8. Agile processes support sustainable development. The sponsors, developers and users should be able to maintain a constant pace indefinitely.
9. Continuous attention to technical excellence and good design enhances agility
10. Simplicity—the art of maximizing the amount of work not done—is essential.
11. The best architectures, requirements, and designs emerge from self-organized teams.
12. At regular intervals, the team reflects on how to become more effective, then tunes and adjusts its

Figure 1. The Agile Principles
(Agile Alliance, n.d.)

The true power of agile is in something often referred to as the "agile mindset." Project managers can embrace agile principles within any development framework. The

focus on value, adaptability to change, and frequent interactions with the customer and stakeholders to ensure that the project remains aligned with enterprise needs are equally applicable in waterfall as they are in scrum. Perhaps the most important principle for project managers to understand is “Simplicity—the art of maximizing the amount of work not done—is essential” (Agile Alliance, n.d.). Often misunderstood, this principle emphasizes a minimalist philosophy of agile. Agile is about focusing on the most important and valuable elements of the product and working very hard to identify and eliminate often costly “bells and whistles.” The concept of challenging early requirements and demonstrating meaningful, if only partial, implementations helps the customer eliminate the extras and focus on the core capabilities required. For example, if the customer’s specification calls for a “fully automated” analytical capability, and an increment delivers a semi-automated feature, the customer may find the semi-automated capability acceptable, thus eliminating significant cost and effort that can now be focused on other “high priority” items. The project manager needs to understand how to define and manage to a minimum acceptable feature set as the top priority for initial efforts. This helps to ensure that the project efforts are not wasted, even if funding is reduced or the project is terminated early. In many cases, the minimum acceptable feature set will allow the enterprise to suspend or terminate projects early, saving funds to be invested in other efforts with a higher value payoff.

Simplicity also applies to project initiation and planning efforts. Rather than expend the effort to create detailed task decompositions and budget estimates that hide inaccuracy behind the illusion of precision, an agile estimate will use expected productivity and estimated size/complexity to provide a range of features to be included given a fixed time or budget constraint. If neither of these is set, it is simple to estimate the time and budget ranges needed to deliver all functionality. As Figure 2 shows, the degree of uncertainty for a project decreases over the life of the project. Estimates performed at the start of the project can be underestimated by 1.6 times or over-estimated by 1.4 times so both the point estimate and the range estimates fall within this margin of error. Risk factors are often applied to the initial estimate to increase the confidence; however, recent research indicates that risk factors applied to elements of the WBS may significantly over and under state the total risk to the project.

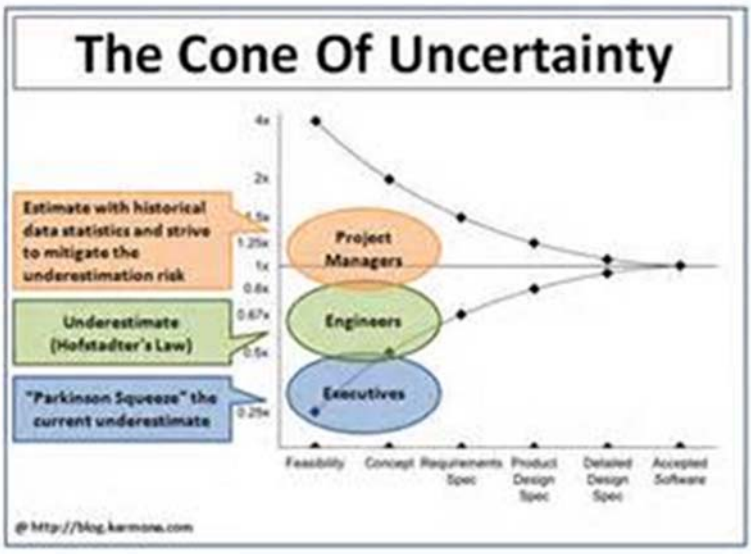

Figure 2. Project Uncertainty and Estimates

Project Complexity

What is project complexity? This question has been asked many times by researchers across the globe, and the answers have varied from paper to paper. Pich, Loch, and Meyer (2001) saw complexity as a result of the degree of project uncertainty. Rather than defining project objectives in terms of cost, schedule and cost, Pich, Loch, and Meyer proposed that complex project success is best defined as a payoff function that is dependent on the world state and decisions made by the project team. Their work proposed a shift in how projects are viewed, from a set of sequential tasks to a decision tree where information was revealed gradually over the course of the project. They stated that traditional project management methodologies, tools and techniques could deal with the known unknowns (referred to as risks), but failed repeatedly to address the unknown unknowns, those unforeseen events that are fairly common in project execution.

Other researchers have defined and categorized complexity causes. Hass (2008) identifies that "there is no widely accepted definition of project complexity that is research based and therefore defensible." Hass (2008) does identify several causes of complexity, such as

- Details—number of variables and interfaces
- Ambiguity—lack of awareness of events and causality
- Uncertainty—inability to pre-evaluate actions
- Unpredictability—the inability to know what will happen
- Dynamics—rapid rate of change
- Social Structure—numbers and types of interactions
- Interrelationships—many interdependencies and interconnections exist

Many of these same causes appear in a 2009 research study focused on defense acquisition in Australia. Members of the Commonwealth Department of Defense (including the Defense Materiel Organization [DMO]), the International Centre of Complex Project Managers (CCPM), and defense contractors such as Lockheed Martin, BAE, Boeing, and Raytheon, identified several themes related to project complexity, ranging from goals and stakeholders, to technology, management processes, and work practices and time (Remington, Zolin, & Turner, 2009).

Williamson (2012) sought to correlate the relationship between project complexity and project success. Working with the Project Management Institute, he conducted a survey in 2012 which established that increased complexity corresponded to lower success rates. An underlying message that emerges from the research on complexity is that our notion of a project as a sequential set of tasks is false. Several researchers (Benbya & McKelvey, 2006, pp. 12–34; Kautz & Madsen, 2010; Kautz, 2012) have explored the similarities of information systems development projects to complex adaptive systems (CAS). From a project management perspective, understanding the nature and structure of CAS is a critical element to successfully manage projects that exist in that domain.

Figure 3 shows both the traditional and complex views of the same project. The traditional view on the left has used reductionism (decomposition) to isolate the component tasks of the project and presents them in a sequential manner. This is the typical Gantt view used to sequence and manage work. When project tasks are reduced to this level, estimating the time and resources required for each task is straightforward. Unfortunately, the act of decomposition obscures the rich set of interrelationships, and the resulting cost and schedule estimates do not add up to the total value expected. The CAS view on the

right shows how the elements of the project, the sequential tasks, can interact with other Comparative Project Views elements. The project manager and project team's understanding of these interrelationships is critical for success.

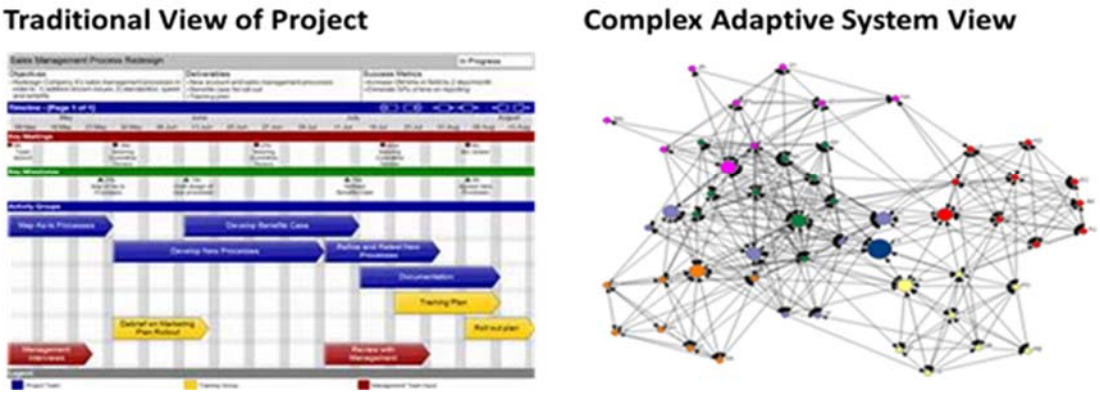

Figure 3. Projects From the Traditional and Complex Perspectives

Kautz (2012) identifies a set of characteristics found in CAS type projects. These characteristics establish the basis for the adaptive management concept.

- Interactions—The rich, dynamic, nonlinear and feedback behaviors of the development process as a whole cannot be known or predicted from an inspection of the components.
- Emergence—The emergent behavior and response to internal and external stimuli cannot be predicted or measured from an analysis of individual components.
- Interconnected autonomous agents (project team) have the ability to independently intervene and determine an action based on perception of the environment as well as sense and respond to change.
- Self-Organization—capacity of interconnected agents to evolve into an optimal organized form without external force to create disciplined interactions
- Co-Evolution—The entire project and its components alter structure and behavior in response to interactions both internal and external.
- Poise at the Edge of Chaos—The project exhibits both stability and instability at the same time. The project never locks into a predictable rhythm but never falls apart. Execution at the edge supports innovation and exploration.
- Time Pacing—The project settles into an internal rhythm that drives the momentum of change. Changes are time as well as event based.
- Poise at the Edge of Time—The project is rooted in the present but aware of the future.

Complexity also limits the utility of traditional project management tools. Analysis and estimation tools such as the Program Evaluation and Review Technique (PERT) and Critical Path Method (CPM) are valid estimating and analysis tools when the specific tasks are known but the expected durations can vary. The Graphical Evaluation and Review Technique (GERT) added Monte Carlo simulation allowed project management professionals to generate distributions of probable project durations, accounting for path

convergence and generalized task distributions. These methods moved from identifying the critical path to predicting if a given task would find itself on the critical path. Carracosa, Eppinger, and Whitney (1998) use the Design Structure Matrix framework to add overlapping tasks and rework into schedule simulations. Ludwig, Mohring, and Stork (1998) added "dynamic policies" (p. 609) for project scheduling that simulated a state where activities times became known gradually over time.

This research develops solid approaches to deal with anticipated risk; however, it fails to address unanticipated events and risk, the unknown unknowns. Additionally, these tools do not provide a set of rules or policies describing how the presence of these risk factors influence project management.

Complex Project Management

Understanding the characteristics and sources of complexity and developing the knowledge and skills to execute in this space with the proper tools is critical for project managers. Recent research based on the complexity framework has provided insight into the nature of projects and how knowledgeable project managers consistently deliver successful results. Terry Cooke-Davies et al. (2011) report the findings of a yearlong series of workshops sponsored by the Project Management Institute (PMI) in 2010–2011. One of the key findings highlights the difference between traditional project management and complex project management. "Traditional project management training emphasizes how to do many things that have been done many times before and for which a lot of standards and road signs are in place" (Cooke-Davies et al., 2011). Those managers who demonstrate consistent success in complex environments have "a different perspective and clear realization that much of what is required involves exploration and 'living off the land,' that is creating what is needed from what the local environment provides at that moment" (Cooke-Davies et al., 2011).

Cooke-Davies et al. (2011) and other recent studies have begun to identify a set of characteristics possessed by project managers with consistently successful results. There are several variations on the list of project manager traits for success. The CIO, in an article titled "Six Attributes of Successful Project Management" (Levinson, 2008), provided the following list:

1. They possess the gift of foresight. They are able to anticipate and head off problems.
2. They are organized, focused on the "Big Picture" and able to prioritize competing priorities.
3. They know how to lead.
4. They are good communicators.
5. They are pragmatic and do not try to overanalyze.
6. They are empathetic. Most importantly, they understand stakeholder concerns and work to address them.

The CIO is not the only organization to publish project management success factors. The Standish Group, in their annual Chaos Report, list project success factors. Table 1 shows how this list has evolved over time by comparing the 1995 version to the 2009 version. It is interesting to note that "Clear Business Objectives" replaced "Clear Statement of Requirements" at number three and that "Proper Planning and "Small Project Milestones" gave way to "Project Management Expertise" and "Execution" in the more recent list.

Table 1. Evolution of Project Management Success Factors

1995	2009
1. User Involvement	1. User Involvement
2. Executive Management Support	2. Executive Support
3. Clear Statement of Requirements	3. Clear Business Objectives
4. Proper Planning	4. Emotional Maturity
5. Realistic Expectations	5. Optimization
6. Small Project Milestones	6. Agile Processes
7. Competent Staff	7. Project Management Expertise
8. Ownership	8. Skilled Resources
9. Clear Vision and Objectives	9. Execution
10. Hardworking, Focused Staff	10. Tools and Infrastructure

The other noteworthy element is the shift to leadership skills in the 2009 list. This is directly related to the evolving thought that the project manager is a leader who motivates and guides the execution of project activities. The shift toward leadership correlates to the inclusion of agile processes as a success factor. The agile movement, starting in 2001, has challenged traditional concepts of project management in ways that are often overlooked as organizations rush to be agile. Too often, agile rituals such as shorter iterations are adopted without thinking through the fundamental changes required for these rituals to be effective.

What emerges from these recent studies is a new profile for project (and program) managers which is supported by research. The traits of a project manager likely to succeed in complex environments include

- Business Focus: Project management decisions are business decisions that flow from the organization strategy and recognize the business value of the effort. This shift reflects a growing perception that the project manager's responsibility is to deliver value within defined constraints and not manage to a pre-defined cost schedule and performance.
- Focus on the Big Picture: Successful project managers constantly focus on value delivery, looking at execution tasks from the perspective, "How does successful completion of this task contribute to creating value?" The project manager understands that there are alternative paths toward value and that his/her primary mission is to move in directions that maximize overall payoff.
- Perceptive, Seems to Anticipate Need for Change: Successful project managers are quick to assess the impact of events, both internal and external, and are ready to adjust. This ability is a result of careful planning to identify essential elements of information and then recognizing them early.
- Leadership: Project managers are leaders. The good ones display empathy, conviction, a positive attitude, and an adaptable style that is appropriate for the situation and the team.
- Communications: Successful project managers know how and when to communicate and, more importantly, how to listen.
- Pragmatic: Successful project managers are not afraid of decisions. They don't over analyze or wait for others. They also empower the team to make tactical decisions because, as leaders, they have communicated the "manager's intent."

How are these traits put into practice? Pich, Lock, and De Meyer's (2001) "model of project uncertainty and complexity" compared several project management approaches

under differing conditions of uncertainty (pp. 5–11). Their results support the concept of a pre-defined project plan and executing to that plan when there is adequate knowledge of the project terrain to create a plan that maximizes the payoff function. They caution that these circumstances rarely exist, especially for information technology projects. A second approach is to have a project plan with specified contingency actions. Again, this approach is most useful when project uncertainty can be anticipated with a degree of certainty. When the uncertainty and associated complexity of a project includes a significant number of unforeseeable events/influences, predetermined plans prove not to be the best project management approach. Under these circumstances, the best results are obtained when the project manager and team integrate a "learning" approach to their execution. Information gathering through either "scanning the horizon" or specific focused knowledge acquisition activities allow the team to learn and the project path to evolve. This "exploration of uncharted terrain" approach consistently achieved the best results under conditions of uncertainty.

A Conceptual Framework for Adaptive Project Management

Through these various studies on project complexity and project management success factors, a well-defined set of project manager skills and knowledge emerges. These skills and knowledge provide the basis for an adaptive approach to project management.

Strong Understanding of Business Value

Perhaps the most important question for a project manager is "Why?" Traditional project management focuses on "What," as in "What is the scope?," "What is the Budget?," and "What is the deadline?" This is adequate under conditions of certainty, where execution simply means following the plan. Unfortunately, to paraphrase a common belief for contingency operations, "plans rarely survive contact with the project." Understanding the underlying business reason and the desired value of the project allows the project manager in a complex environment to adjust and adapt within the value construct and to identify when key stakeholders need to be brought into the discussion because the available options result in the need to modify the value expectations. Harold Kerzner, speaking at the International Project Management Day conference in 2008, noted that project managers

- are involved in strategy and project selection processes and are expected to provide execution perspectives
- have expertise in business with some technical knowledge. Project managers are first and foremost expected to make sound business decisions.

As the Chaos report on success qualities in project managers indicates, there has been a shift toward project managers having in depth business skills with some technical knowledge. In part, this is due to a growing realization that project management decisions are business decisions related to the defining and prioritizing of activities and not the management of work.

Plan Is a Verb, Not a Noun

Traditional, prescriptive project management centers on developing and executing the project plan. Successful project managers in complex environments "Focus on the end goal and manage all elements to that end rather than trying to manage the individual components" (Cooke-Davies et al., 2011). Project managers who demonstrate consistent success in complex environments tend to plan and think in terms of the big picture. Planning focuses on understanding the intended flow of the project as well as how internal and external events can influence that flow. The natural tendency to address complexity through

reductionism, which means to decompose complex elements into simple subsets, tends to restrict vision to a prescribed path, as shown in Figure 4.

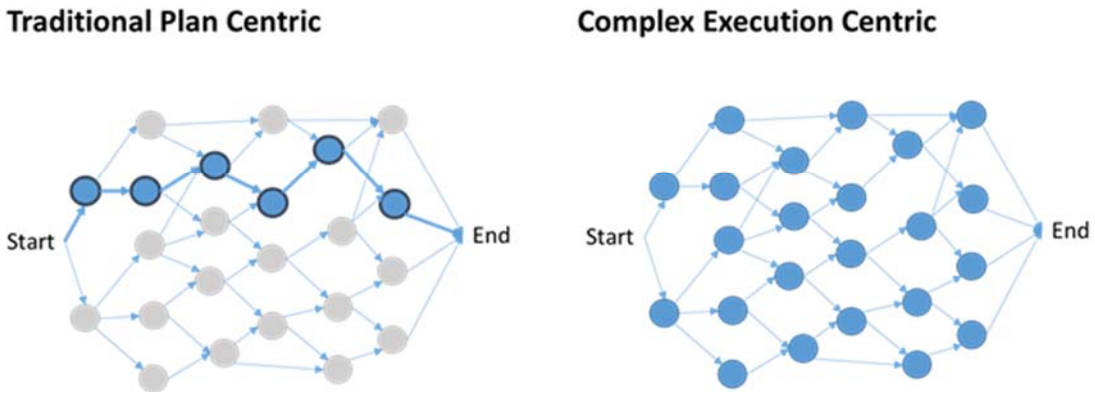

Figure 4. A Plan Centric View Obscures Options and Alternative Paths; Execution Centric Helps Identify Decision Points

Developing the traditional project plan requires a number of assumptions that establish the preference for one alternative over other available alternatives. As the plan is refined through increasingly detailed analysis and estimates, the project team becomes blind to the assumptions and how much error those assumptions have introduced. As execution progresses and assumptions prove to be in error, the project manager will often resort to expensive (in terms of time and resources) efforts to return to the plan because an alternative and less costly route is not readily apparent. Again, this was reiterated in research by Pich et al. (2001) and others.

In contrast, studies have found that successful project managers in complex environments plan at the macro level, focusing on identifying potential alternatives and the assessments required to decide. During this initial planning effort, unknown elements are identified and analyzed to see where they fit in the process flow, as are the project decisions that the unknown factors impact. Rather than make assumptions that support a specific project path, unknown elements are mapped to decision points based on how they impact the project, and external and internal factors that could influence the project end state are identified. Alistair Cockburn (2006) talks about the three elements of any project being the product, product knowledge, and process knowledge. Each is important for project success and therefore needs to be incorporated into project planning. A knowledge acquisition plan begins to unfold based on a policy stressing the value of knowledge and the cost of acquisition. Knowledge acquisition is not free. There are significant differences in the cost of knowledge based on the acquisition method used. Scanning the horizon or general observation is relatively inexpensive. Dedicated knowledge acquisition activities are significantly more expensive and therefore need to be used judiciously. There is also a decreasing value of additional knowledge. Once the project manager or team recognizes an event and identifies a potential impact, the law of diminishing returns applies to additional attempts to refine the information.

Nothing in this discussion of planning in complex environments is meant to imply that detailed planning does not occur. The CIO, in its discussion of success characteristics, noted that complex project managers are capable of producing detailed decompositions of project tasks quickly and accurately. The article goes on to point out that these project

managers understand that these detailed decompositions reflect only one of a number of potential paths to completion (Levinson, 2008).

There are a number of similarities between leading a force in a contingency operation and executing a complex project. Army Field Manual 100-7*, Decisive Force: The Army in Theater Operations,* provided a model for complex project planning. It characterizes "Operational Art" as tactical and operational engagements designed to achieve strategic objectives (Department of the Army, 2005). The concept of "branches and sequels" is just as valid in project management as it is in contingency operations. Simply stated, branches are contingency plans for changing disposition, orientation, or direction of movement based on specific indicators and warnings. Sequels are actions taken after an event based on possible outcomes—victory, defeat, or stalemate (Department of the Army, 2005). Project managers who successfully navigate complex projects include branches and sequels in their plans. A change in direction or branch may be indicated by external events, while sequels are planned following key decision points in the project.

An added benefit of complex planning methodologies is that the analysis of decision points identifies a set of logical project review points often calling for stakeholder decisions on project direction. These natural governance points will normally be event based rather than calendar driven.

Empathy and a Pragmatic Approach

There is general agreement that success in complex project environments is often the result of the creativity, imagination, openness and flexibility of the project manager and the team. A common finding was that successful project managers displayed both passive and active empathy. Passive empathy is the level of consciousness in anticipating and predicting situations and taking control before they become problems. In reality, the experienced project manager has perfected his or her OODA Loop (Figure 5). Originated by Colonel John Boyd (USAF), the OODA (Observe, Orient, Decide and Act) loop represented the decision making and action cycle of a fighter pilot. Colonel Boyd stated that he could win any air engagement, starting from a position of disadvantage, simply because he operated on a faster decision cycle. Since originally proposed, the OODA loop concept has been used in a number of professions, including project management.

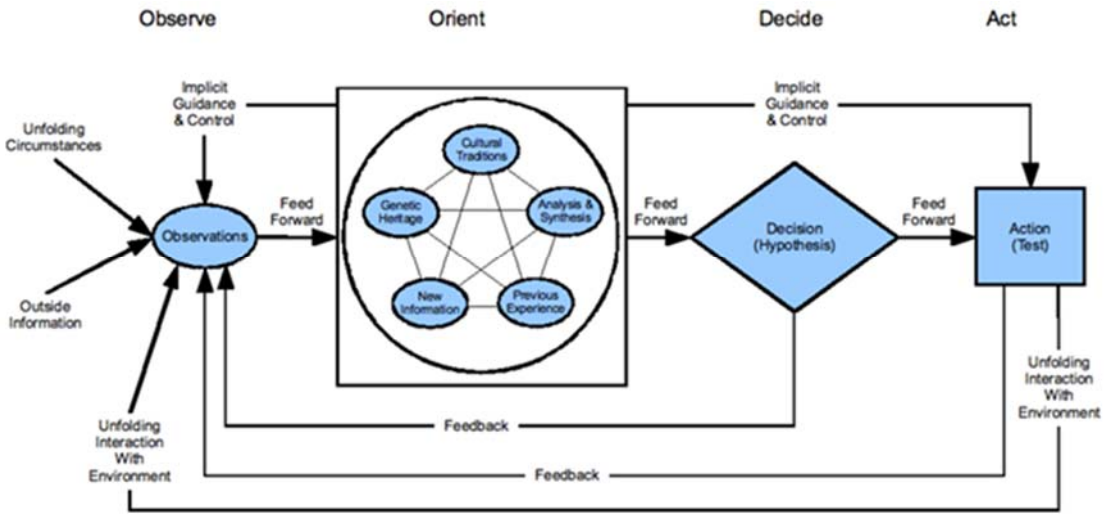

Figure 5. The OODA Loop
(Kallokain, 2008)

For the project manager, the challenge is to understand what to observe and how to operate in tune with the project flow as an autonomous agent, steering project execution consistently toward the goal. Additionally, as the leader of the effort, the project manager has to influence how members of the project team observe and respond to unfolding events and emerging information.

One of the key functions of the decision process is in knowledge acquisition throughout the planning and execution phases of the project. As stated previously, unknowns and uncertainty are not cloaked by assumptions. Instead, yet to be revealed information is mapped to the decisions it impacts, and plans for discovery are integrated into the project. In some cases, these may be implemented as what agile proponents call technical spikes; however, many times the information can be discovered through inquiry and expanding the project horizon. The goal is to gain sufficient knowledge to support decisions at the last responsible moment. The last responsible moment is an agile term used in lean development to reflect the requirement to decide at the point where further delay results in the loss of a valuable alternative. The concept is that decisions made too soon in the process do not take advantage of potentially valuable information, while procrastination leads to the loss of choices. Project managers need to guide this process, especially when key stakeholders are involved in the decision, to be sure that all decisions are made with the best available knowledge.

Management of the decision process to align with the concept of the last responsible moment is, in many ways, a corollary to normal decision models which focus on the right side of the decision by assessing the consequences of various choices. Here we are focusing on the left side to ensure that decision analysis benefits from the most knowledge possible.

Communications Is Key

Project management and successful execution in complex environments relies on communications. The project manager sets the tone and leads by example, but all members of the project team have the responsibility to communicate frequent and meaningful content. The project manager, just as the commander in a contingency operation, must clearly communicate his/her intent and continue to communicate intent throughout the planning and execution. Stephen Covey (1992) stated that “much of true leadership is exercised by communicating a vision and plan that appeals to the values of people through principles” (p. 24).

Effective, efficient communications is the unifying force that helps bring the self-organizing team of autonomous agents together in a synchronized group. Shared observations help all members expand the observe phase of the OODA loop, while communications regarding decisions and actions at the tactical level of execution aids the entire team in assessing the impact and reinforcing progress through synchronized actions.

Communications and transparency are also key elements to keep key stakeholders involved and engaged throughout the project lifecycle. Observables or “information radiators” enable team members and stakeholders to quickly come up to speed on progress and to identify elements needing additional attention. Software development teams use burn down charts to show progress on delivering required features. Kanban charts help visualize where specific elements are in the development lifecycle. At the project level, Gantt and milestone charts, with their sequential representation, are poor representations of project activities. PERT charts, with activities on nodes, help display the interconnections among the elements and show progress across the many project engagements. The problem is

current project management software tools are good at creating and displaying Gantt charts, but do a poor job in providing clear, easily understood PERT depictions.

Appropriate Project Management Tools

A key training issue facing organizations today is how to prepare project managers to succeed on complex projects. Certifications such as offered by DIAWA and the PMI provide a solid baseline but are generally focused on traditional, prescriptive project methodologies. Training available on agile methodologies tends to focus on the software development side and does not provide insight for project managers.

A project manager in a complex environment needs to understand the various methodologies, their limitations and benefits, and how they can be adapted for a specific implementation. He/she also needs to understand how tools used in the traditional project environment can be adapted to function in a complex environment. For example, earned value is often used to assess the feasibility of the plan. This same set of calculations, applied to the range of efforts in a complex environment, can help identify where attention is needed because progress is lagging. Unlike the traditional use, earned value provides insight into where adjustments are needed to the execution, either by increasing the effort in a specific set of activities or to pull back, regroup, and try an alternative path.

Governance in an Adaptive Environment

Organizational oversight and governance is always an issue as one moves away from the prescriptive project management model. Wysocki (2014) states that the "current business climate is one of unbridled complexity, change, and speed. … This situation has placed a significant challenge on organizations and their project managers in that traditional project management tools, templates, and processes are no longer effective" (pp. 3–4).

Organizational complexity is a factor that sound governance policies can minimize. Project Value Delivery, in a 2013 white paper, stressed the need to minimize internal organizational complexity to help reduce overall project complexity. They cite multiple reviews, multiple overlapping review panels, and hierarchical review process as examples of organizational complexity impacting project execution that can be streamlined or eliminated. They recommend a "sound governance structure" potentially tailored for the project.

Wysocki (2014) believes that regular stakeholder reviews are critical in ensuring that the project remains aligned with the enterprise vision. Reviews are needed at Project Initiation to assess the affordability of the project, when the project plan (similar to a campaign plan) is reviewed, and then when needed for key decisions. The final review, after project close out, serves as a retrospective where the project manager and key stakeholders review what went well and where there is need for improvement.

Training Project Managers for Complexity

Project managers who can successfully navigate and deliver results in complex environments are not born. Today, most are accidents of experience, thrown into complex projects without a net and surviving. This doesn't have to be the case. Within the DoD, we train leaders and help them develop and apply these same skills, usually in combat command positions. The parallels between project leadership and troop leadership are clear.

Traditional project management training emphasizes how to do many things that have been done before and for which a lot of standards and road signs exist. Managers come out of these training environments believing that every problem has a solution for which there is a paved road or high-speed rail line that will get them to their destination. As

Wysocki (2014) characterizes the situation, we are training cooks when we need chefs: “A cook is trained and experienced to follow recipes developed by someone else. A chef is that someone else” (p. 31).

Training needs to emphasize leadership, critical thinking, observation and situational awareness. Much of this are the same things we teach combat commanders, but with a project focus. Additionally, project managers need to understand the various tools available to them and when and how they are used. Project managers need to understand how various development and project methodologies function and how to tailor for a specific project.

Finally, training is needed on tools and techniques for stakeholder interactions and how to drive to key functionality. For example, in agile development, it is often useful to gather user representatives in a room, hand them a stack of play money (representing the budget), and have the various functions of the development effort arrayed on the table and priced. The users are asked to prioritize the functions, deciding what is above and below the line. The value for the project manager and the team is not the final prioritization, but the discussions that take place describing what could be cut from a high priority item and what elements from lower features would be elevated. This insight is invaluable during execution when tough decisions are required.

Beyond formal training, the key to developing project managers able to succeed in complexity is on the job training and mentoring. The Project Management Institute recommends establishing a mentoring program. In fact, *The Project Manager Competency Development Framework* cites an effective mentoring program as a leadership performance criterion (Project Management Institute, 2007). Mentors need to be trained to be effective, and they must have the correct temperament to be effective.

Job assignments need to be managed to provide project managers with the opportunity to learn by doing.

Conclusion

Researchers have made significant progress in understanding the nature of project complexity and the skills and characteristics project managers need to succeed. Project managers are leaders, and additional research is needed to understand how military commanders at all levels perform in complex contingency environments. Formal project manager training programs need to address the skills and competencies needed in complex environments. Assessing skills and knowledge needs to move away from multiple choice tests to practical exercises where there is no “school solution.” In the DoD, this level of training is available to senior program managers at the 400 level of DAU classes. That type of training needs to flow downward to intermediate level classes.

More research is needed to refine project management education and training. Specifically, research is needed to refine the success traits of successful project managers. Specific tools and techniques used by these managers need to be catalogued, along with the concepts that led to the selection of specific tools and how the use was adapted. DoD project managers need to understand how to identify project specific indicators and warnings and how to apply the OODA loop in a project context. Finally, research is needed to identify and recommend solutions to eliminate controllable complexity in defense acquisition.

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