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ACQUISITION RESEARCH PROGRAM

The Application of System Dynamics to Naval Contracting Acquisition Workforce Issues

Interim Technical Report

November 2016

David N. Ford, Ph.D., PE

Graduate School of Business & Public Policy

Naval Postgraduate School

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

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Abstract

Acquiring effective and efficient materiel solutions that support naval missions and other operations is critical to meeting Department of the Navy (DoN) objectives. This requires that the Navy maintain an acquisition workforce that is large enough and qualified enough to fill acquisition demands. The naval acquisition workforce faces losses of experience and capacity as the current workforce ages and retires. This project applies the system dynamics method to naval contracting acquisition workforce issues. This interim report describes the need for and design of a workshop with naval contracting workforce leaders.

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Introduction

Challenges Facing the Department of the Navy Acquisition Workforce

Department of the Navy (DoN) acquisition provides materiel solutions and services to fulfill the Navy's mission and support operations. To do this the DoN acquisition workforce manages the planning, design, procurement, manufacturing and construction, testing, and making-ready-for-use of those solutions. This requires thousands of contracts, millions of contract actions, and billions of dollars each year. The DoN acquisition workforce must be both effective and have adequate capacity to fulfill the demand for naval acquisition. The DoN faces several challenges in providing an adequate acquisition workforce. First, the demands placed on the acquisition workforce are changing. The naval fleet is growing toward a target of more than 300 ships (DoN, 2015). This requires increases in acquisition capacity (Government Accountability Office [GAO], 2012). In addition, materiel solutions are becoming increasingly complex as threats and the technologies needed and used to meet and defeat those threats evolve. This requires that the acquisition workforce have more and different knowledge and skills than were required in the past. In addition to these demand-side challenges, the DoN faces challenges in providing and maintaining its acquisition workforce. The current acquisition workforce is relatively old. Therefore the workforce is currently losing, and will soon lose more, experience and capacity as members retire or seek employment elsewhere. This will require the DoN to recruit and train new acquisition personnel.

The DoN acquisition workforce includes many diverse parts, processes, and stakeholders that interact over time in a wide variety of ways. This prevents solutions that address individual parts (e.g., training, assignment rotation) or aspect (e.g., economics, experience levels) of the system and its challenges from being completely successful. Therefore, addressing DoN acquisition workforce challenges requires a systems perspective and systems level solutions. The tools and methods that facilitate that perspective and those solutions must be able to integrate the numerous and diverse aspects of the workforce (e.g., specialization, training, experience, assignment rotation and advancement, and location) and measures of

workforce performance (e.g., capabilities and capacities). Understanding the interactions among workforce components is critical to developing improved policies. Developing that understanding is not intuitive or obvious. Largely because the workforce and its performance are dynamic, they evolve in response to system structure, current conditions, and current and future policies. Those interactions create causal feedback loops, unintended side effects, delays, and resistance to otherwise well-designed policies. Improving acquisition workforce understanding and developing effective and efficient policies requires tools and methods that can capture the systemic, dynamic feedback in the system and current and future policies. Those tools and methods must also reflect the impacts of those system features on workforce performance.

Background

The Department of Defense Acquisition Workforce

The Defense Acquisition Workforce (DAW) obligates over $300 billion annually to acquire goods and services.[1] The GAO has reported on the need for ensuring that the DAW is adequately sized, trained, and equipped to meet DoD needs. To help address some of the challenges, Congress created the Defense Acquisition Workforce Development Fund. The Fund has been applied to a variety of uses, including increasing the size of the workforce. The "Better Buying Power" initiative (DoD, 2015) also addresses acquisition workforce needs. It includes improvments in recuriting and hiring, training and development, and retention and recognition. These efforts have improved the DAW. For example, acquistion workforce certification has generally increased (Figure 1).

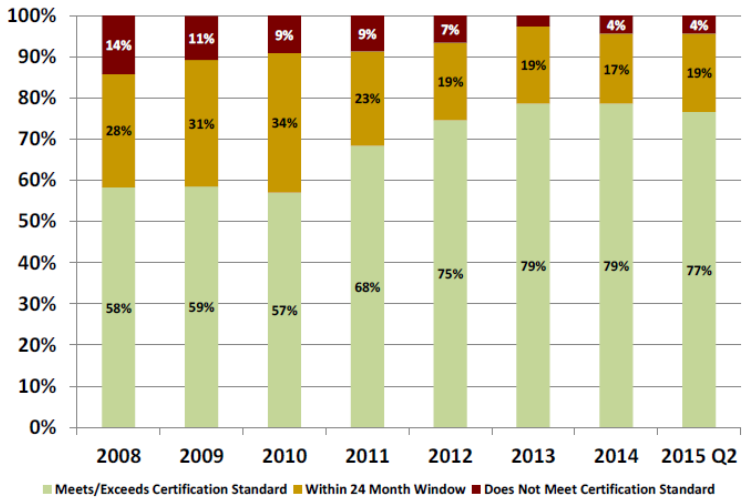

Figure 1. Acquisition Workforce Meeting Certification Standards (2008–2015Q2) (DoD, 2015, Figure 4-1)

However, significant additional improvement is still required to meet DoD needs. The 2015 "Performance of the Defense Acquisition System" report (DoD, 2015) identified five measures of acquistion performance that require improvement and offered many insights that point to additional areas where changes can improve acquisition. However, as described, the tight interdependencies within the defense

[1] In the president's budget, $161.2 billion is obligated specifically to the Navy (DoD, 2015).

acquisition system can severely limit improvement if the various parts of the workforce challenges are addressed separately.

System Dynamics

The research described herein applies the system dynamics modeling methodology to DoN contracting workforce issues. The system dynamics methodology combines a broad perspective of systems with a control theory approach to improve the design and management of complex human systems. System dynamics combines servo-mechanism thinking with computer simulation to allow the analysis of systems in ways that are not possible with human reasoning alone. It is one of several established and successful approaches to systems analysis and design (Flood & Jackson, 1991; Jackson, 2003; Lane & Jackson, 1995). Forrester (1961) developed the methodology's philosophy, and Sterman (2000) specified the modeling process with examples and described numerous applications. When applied to engineered systems such as the defense acquisition workforce, system dynamics focuses on how performance evolves in response to interactions within the causal structure of the system (e.g., retirement rates, development of knowledge and experience), development and management policies (e.g., training developed in specialty areas), and conditions (e.g., capacity levels, budget constraints). System dynamics is appropriate for modeling the acquisition workforce because of its ability to explicitly model the diverse set of critical features, characteristics, and relationships that drive behavior and performance.

System dynamics has been applied to military systems, including planning and strategy (Bakken & Vamraak, 2003; Duczynski, 2000; McLucas et al., 2006; Melhuish et al., 2009), workforce management (Bell & Liphard, 1978), technology (Bakken, 2004), command and control (Bakken & Gilljam, 2003; Bakken, Gilljam, & Haerem, 2004), operations (Bakken, Ruud, & Johannessen, 2004; Coyle & Gardiner, 1991), logistics (Watts & Wolstenholme, 1990), acquisition (Bartolomei, 2001; Ford & Dillard, 2008, 2009a, 2009b; Homer & Somers, 1988), and large system programs (Homer & Somers, 1988; Lyneis, Cooper, & Els, 2001). Coyle (1996) also provided a survey of applications of system dynamics to military issues.

Problem Articulation

When applying the system dynamics method as described by Sterman (2000), the first step is problem articulation. The purpose of problem articulation is to identify the issue or issues that will serve as the focus of the work and to develop descriptions of the nature and extent of those issues. Focusing on issues and not a system is critical for the successful application of system dynamics because the usefulness of models of all kinds lies in their simplification of reality for purposes such as analysis and the design of solutions. Models that are accurate representations of entire systems such as the DoN contracting workforce would be too large and complex to be useful.

Problem articulation began with discussions with selected DoN contracting leaders in several Navy System Commands (SysComs). A set of questions was developed to facilitate discussions (see Appendix A). Meetings with those leaders occurred in June 2016. Subsequent discussions with the Navy Defense Acquisition Career Management (DACM) office identified system dynamics as a potentially valuable approach to addressing Navy contracting workforce issues and a workshop with selected Navy contracting personnel as a valuable next step. That workshop would introduce system dynamics and develop the systems modeling skills of the participants.

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Workshop Design

The workshop was designed to occur over a day and a half at DoN facilities near the Pentagon. Conceptually, the first day was planned to transfer knowledge and develop system dynamics skills in participants through interactive exercises and applications to DoN contracting workforce issues. The second morning was planned to complete applications and prepare to present to DACM leadership.

In addition to introductions and logistics, the workshop design consisted of five modules:

- Introduction to system dynamics
- Modeling with stocks and flows
- Modeling causal feedback
- Applications to DoN contracting workforce issues
- Formal system dynamics modeling for insight and policy design—an example

Introduction to System Dynamics

The first module will provide an overview of system dynamics as a methodology for understanding and improving dynamically complex systems. The central concepts of accumulations and movements of people, materials, and information through systems will be introduced, as will the use of conceptual and formal simulation models. Their use to understand how the structure of systems drive and constrain system behavior and performance will be described. Dynamic behavior and causal feedback are explained as the central features of challenges that system dynamics addresses. Several examples will be provided. This module concludes with the needs that managers have for modeling dynamic feedback systems, such as the DoN contracting workforce.

Modeling with Stocks and Flows

The standard system dynamics nomenclature for modeling stocks and flows will be articulated. Several examples will be used to demonstrate the use of stocks and flows for perceiving systems. The first workshop exercise poses the

circumstance that “a SysCom’s contracting manager wants to model what will impact the size of the SysCom’s contracting workforce in the future” and asks the workshop participants to work in teams to model the system with stocks and flows. Facilitated discussion are planned to enrich participant understanding. The exercise will then be expanded to incorporate experience levels in the model. Important lessons from the module are repeated, including the need to model important, as well as easily-measured, system components; the value of using stocks and flows for creating visual maps of systems, and their use to improve dynamic intuition.

Modeling Causal Feedback

This module was designed to introduce causal loop diagramming and develop conceptual modeling skills. The use of causal links and link polarity will be explained and illustrated, including in stock and flow models. A simple example from DoN contracting workforce practice will be used to illustrate (Figure 2).

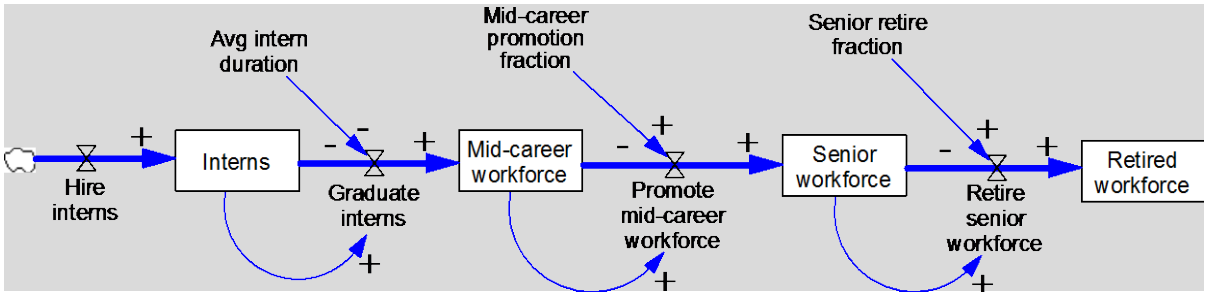

Figure 2. Example Stock and Flow Model with Causal Links and Link Polarities

This will be followed by an explanation of the two types of feedback loops (reinforcing and balancing). A simple example (bank balance and withdrawals) and examples from DoN contracting practice will be used to illustrate these principles and tools (Figure 3).

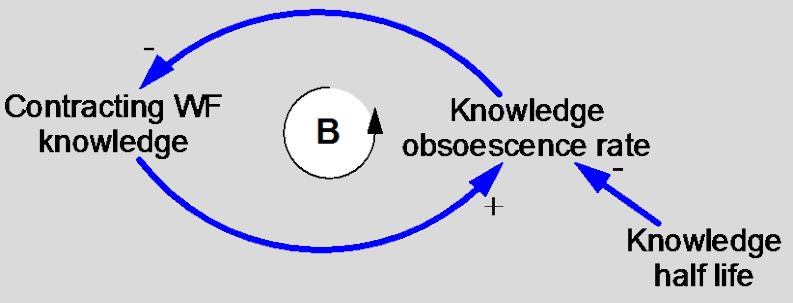

Figure 3. Example Causal Feedback Loop Diagram

Participants will learn the behavior modes that are generated by each feedback loop type, how to determine the type of feedback loop from the causal feedback structure, and how to predict the behavior mode. Several examples of each type of behavior mode will be provided, including examples from DoN contracting (Figure 4).

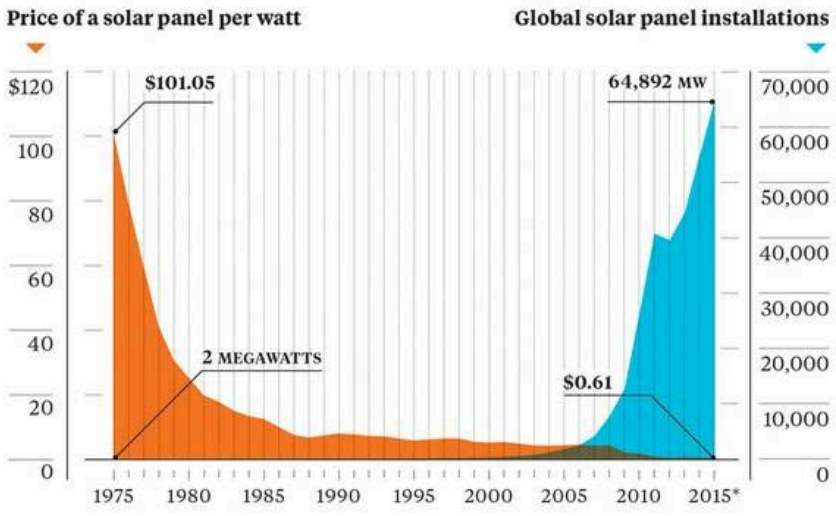

Figure 4. Example of Behavior Modes Generated by Balancing (Left) and Reinforcing (Right) Causal Feedback Loops ("Explore Global Solar, Vs Global, and More!," n.d.)

System structure diagrams that integrate stock and flow diagrams with causal loop diagrams will then be described and illustrated with the same examples used for the DoN contracting workforce (Figure 5).

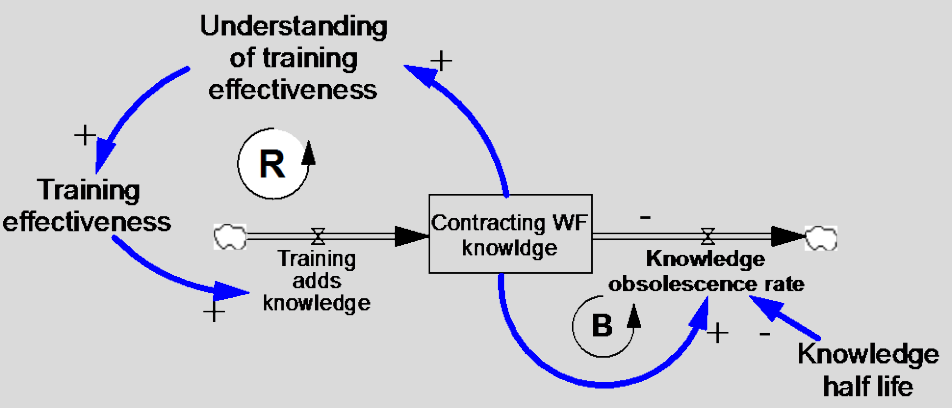

Figure 5. Example of a System Structure Diagram

A multi-step feedback modeling exercise will be used to build modeling skills. This exercise will be based on the following prompt: “A workforce deficit increases pressure to produce on those in the workforce. This makes those jobs less attractive, increasing attrition, which impacts the size of the work force.” A multi-step feedback modeling exercise based on the prompt “A workforce deficit increases pressure to produce on those in the workforce. This makes those jobs less attractive, increasing attrition, which impacts the size of the work force.” will be used to build modeling skills. Important lessons learned from this introduction will be reinforced at the closing of this module, including the role of causal loop diagrams and system structure diagrams and the importance of understanding feedback loop strength for explaining how structure drives behavior.

The module will continue about the topic of the impacts of feedback on system behavior and performance. Policy resistance will be defined, described, and illustrated, first using an example of a manager using overtime to control a project’s schedule performance. A second example concerning a low-bid supplier will reinforce the central concepts. The common better-before-worse behavior mode that is often generated is explained. This will lead to a discussion with the workshop participants about examples of policy resistance that they have experienced. This

will be followed by an exercise in modeling policy resistance based on a training need in an engineering organization. Lessons learned will include that we must model the feedback to manage policy resistance.

High leverage points are the second impact of feedback on system behavior and performance. These are defined and places where small changes can have very large effects. The common role of high leverage points in our culture will be illustrated by the fable of the Lion and the Mouse by Aesop and several small examples from modern culture. These show that high leverage points are points of power. The workshop participants will be facilitated in developing an example of a high leverage point in the DoN contracting environment.

Applications to DoN Contracting Workforce Issues

The workshop participants will be guided through the application of system dynamics to one or more DoN issues using the following process:

- Agree on a story and focusing question—GROUP ACTIVITY
- ID variables to “tell the dynamic story.” Agree on definitions/meanings. —GROUP ACTIVITY
- Develop reference modes—GROUP ACTIVITY
- Build models that describe the problem—TEAM ACTIVITY
- Share and discuss problem models—GROUP ACTIVITY
- Expand models to include potential solutions—TEAM ACTIVITY
- Share and discuss solution models—GROUP ACTIVITY
- Evaluate models for insight—GROUP ACTIVITY

Potential issues will be suggested, discussed with workshop participants, and agreed upon.

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Formal System Dynamics Modeling for Insight and Policy Design—An Example

An example of the use of formal simulation modeling will be presented based on this issue: “How does constant attrition impact hiring rates and size of the contracting workforce?” A simple conceptual model will be used to structure the problem (Figure 6).

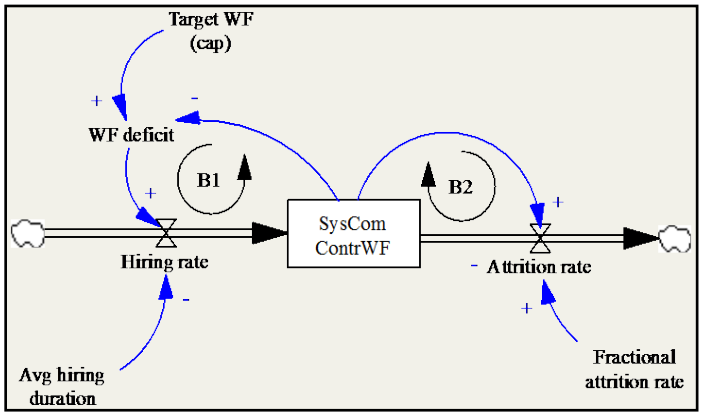

Figure 6. System Structure Diagram for Formal Simulation Example

The results of simulation and their explanation will inform participants in how formal simulation can improve system understanding and policy design (Figure 7).

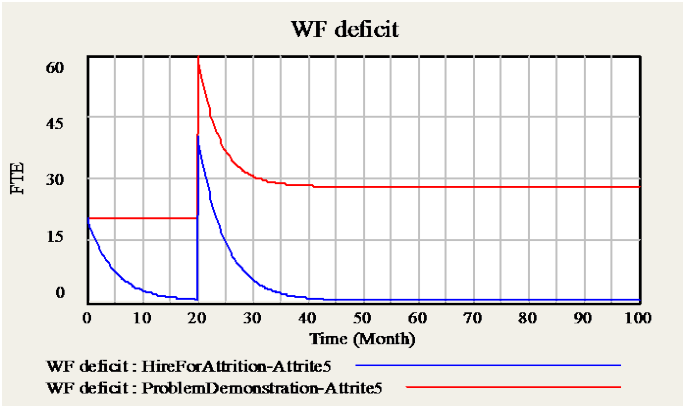

Figure 7. Example of Results of Formal Simulation

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Discussion and Future Work

It is expected that the workshop will achieve both of its primary objectives: to introduce system dynamics to a select group of DoN contracting practitioners and to initially apply system dynamics to one or more contracting workforce issues. The workshop is scheduled to occur in early October 2016. Based upon the results of that workshop, it is expected that one or more workshop participants will present about their workshop experience at a subsequent acquisition workforce meeting. The feedback from the workshop and meeting will be used by the DACM and investigator as a basis for designing how best to apply system dynamics to address DoN acquisition workforce issues.

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Appendix A: Problem Articulation Questions

Status, Policies, and Practices in Managing the Naval Contracting Workforce

TOPIC 1: Current Status of the Naval Contracting Workforce

Q1.1: Approximately how many persons are in the workforce in your organization? How many are at what levels of experience?

Q1.2: What is the average annual net hiring/separation rate at different levels of experience and how has it changed?

Q1.3: What are the primary causes of separation from the workforce in your organization?

TOPIC 2: Policies and Practices in Managing the Naval Contracting Workforce

Q2.1: What policies and practices are used to manage retention of the workforce in your organization?

Q2.2: What training beyond how to use the FAR is provided to the workforce? Describe the general content and duration of that training.

TOPIC 3: Challenges in Managing the Naval Contracting Workforce

Q3.1: What challenges are faced in managing the workforce in your organization? Describe the nature and extent of challenges related to hiring, retention, etc.

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