A New Glide Path: Re-Architecting the Flight School XXI Enterprise at the U.S. Army Aviation Center of Excellence

By

James R. Enos

Bachelor of Science in Engineering Management
United States Military Academy, 2000

Submitted to the System Design and Management Program
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Master of Science in Engineering and Management

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Massachusetts Institute of Technology
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Signature of Author____
James R. Enos
System Design and Management Program

Certified by____
Deborah J. Nightingale
Thesis Co-Supervisor
Professor of Practice of Aeronautics and Astronautics and Engineering Systems

Certified by____
Donna H. Rhodes
Thesis Co-Supervisor
Senior Lecturer, Engineering Systems Division

Accepted by____
Patrick Hale
Director
System Design and Management Program

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Abstract

This thesis utilizes eight Enterprise Architecture views to analyze the U.S. Army Aviation Center of Excellence's Flight School XXI Enterprise and provides recommendations to improve the effectiveness and efficiency of training aviators. The Enterprise Strategic Analysis and Transformation tool provides a guide for understanding the current state of the enterprise and identifying potential areas for improvement. Surveys of the enterprise stakeholders provided an analysis of the stakeholder values and the current enterprise value delivery. Historical data from the U.S. Army Aviation Center of Excellence provided the remaining data for the analysis. A System Dynamics model applied the research to understand the dynamics of the AH-64 training process and conducted an analysis of potential courses of action to stabilize the process. By adding weather days to the Program of Instruction and increasing the daily flight window from 3 to 3.5 hours the enterprise can stabilize the training process. The principles of lean thinking provided a guide for the remaining recommended actions to improve the performance of the enterprise. These recommendations included reducing the batch size of students per course, achieving continuous flow by cancelling initial course, and achieving customer pull by aligning aviator production to the aviation force structure. The thesis provides the leadership of the U.S. Army Aviation Center of Excellence with a glide path to transform Flight School XXI into a lean enterprise and achieve the Army's current and future training requirements for aviators.

Thesis Co-Supervisor: Deborah J. Nightingale
Title: Professor of Practice of Aeronautics and Astronautics and Engineering Systems

Thesis Co-Supervisor: Donna H. Rhodes
Title: Senior Lecturer, Engineering Systems Division

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Acronym List

ACLC:	Aviation Center Logistics Command
AFS:	Army Fleet Support
AMCOM:	Aviation & Missile Command
ARFORGEN:	Army Forces Generation
ATRRS:	Army Training Requirements and Resource System
BOLC:	Basic Officer Leadership Course
CAB:	Combat Aviation Brigade
COE:	Center of Excellence
CSC:	Computer Science Corporation
CW5:	Chief Warrant Officer 5
DOTMLPF :	Doctrine, Organization, Training, Material, Leadership, Personnel, and Facilities
DSM:	Decision Support Matrix
ESAT:	Enterprise Strategic Analysis and Transformation
FORSCOM:	Army Forces Command
FS XXI:	Flight School XXI
GTIMS:	Gradate Training and Integration Management System
HOST:	Helicopter Overwater Survival Training
HRC:	Human Resources Command
IERW:	Initial Entry Rotary Wing
IP:	Instructor Pilot
JOPD:	Junior Officer Professional Development
LTC:	Lieutenant Colonel
MAJ:	Major
MG:	Major General
PME:	Professional Military Education
POI:	Program of Instruction
POL:	Petroleum, Oil, and Lubricants
QDR:	Quadrennial Defense Review
SMDR:	Structure and Manning Decision Review
SERE:	Survival, Evasion, Resistance, and Escape
TRADOC:	Training and Doctrine Command
UAV:	Unmanned Aerial vehicle
USAACE:	United States Army Aviation Center of Excellence
WBS:	Work Breakdown Structure
WOBC:	Warrant Officer Basic Course

Biographical Note

James Enos is an active duty Army Major currently pursuing a Master's of Science Degree in Engineering and Management as a prerequisite for subsequent assignment as an Instructor in the Systems Engineering Department at the United States Military Academy at West Point. He is a combat veteran who served as an Infantry officer in multiple command and staff assignments including Ft. Carson, Colorado; Camp Rudder, Florida; Ft. Campbell, Kentucky; and two deployments to Iraq.

Major Enos most recently served as Battalion Operations Officer for 1st Battalion, 12th Infantry Regiment at Ft. Carson, Colorado. Previously he served as the Commander for Dog Company, 1st Battalion, 9th Infantry Regiment in Ramadi, Iraq and at Fort Carson. Other assignments include Rifle Platoon Leader, Company Executive Officer, Ranger Instructor, and Battalion Assistant Operations Officer.

Major Enos is a graduate of the Infantry Captain Career Course, Ranger School, Airborne School, Air Assault School, and the Infantry Officer Basic Course. His awards and decorations include the Silver Star, two Bronze Star Medals for service in Iraq, Meritorious Service Medal, Army Commendation Medal for Valor, Army Commendation Medal, the Army Achievement Medal, the Airborne and Air Assault Badges, the Ranger Tab, the Expert Infantryman's Badge, and the Combat Infantryman's Badge.

Major Enos graduated from the United States Military Academy in 2000 with a Bachelor of Science Degree in Engineering Management. This work completes the requirements for his Masters of Science in Engineering and Management from the Systems Design and Management Program at the Massachusetts Institute of Technology.

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I would like to first thank my wife, Jamie, for her love and support throughout this endeavor, for yet again putting her career second, and for tolerating the separation during the January term, conferences, and research trips during this "non-deployable" assignment. Thank you for providing a sounding board for ideas and helping with editing when needed.

I appreciate the efforts of the leadership of the U.S. Aviation Center of Excellence for allowing me to utilize their enterprise as a topic for my thesis and supporting the transformation effort. MG Barclay provided instrumental leadership in acknowledging that the Flight School XXI Enterprise has the opportunity for improvement and allowing me to assist in this effort. I would also like to thank LTC Kevin Fowler for facilitating my trips to Ft. Rucker to conduct research on the enterprise and for helping to open doors within the enterprise.

I would like to thank the members of the Flight School XXI team at Ft. Rucker who provided data and information on aviator training at Ft. Rucker. LTC(R) Wayne Pollard who provided the catalyst for this thesis by pushing to improve the training process and gaining recognition that the iceberg was melting. CW5(R) David Wiedemann who worked to pass his years of knowledge as an instructor pilot and aviator to an Infantry Major with no understanding of aviation training and provided the contacts and information necessary to complete this thesis. MAJ Jennifer Bailey, the 110th Aviation Brigade S3, who provided the historical data necessary for me to analyze the enterprise and who facilitated interviews with key stakeholders in the enterprise. Finally, to the instructor pilots, students, Battalion Commanders, and other members of the Flight School XXI Enterprise who took the time to complete the surveys that provided valuable information and insights into the training process.

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Finally, I have to thank my two thesis advisors, Prof. Deborah Nightingale and Dr. Donna Rhodes for their insight and guidance throughout this effort. To work with one of you would have been outstanding in and of itself, but to work with both of you was an opportunity that I will not forget and am better for it.

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Executive Summary

Introduction

This thesis applies an Enterprise Architecture reference framework (Nightingale and Rhodes 2004) and lean thinking to the U.S. Army Aviation Center of Excellence's Flight School XXI Enterprise. The primary research objective is to determine how to reduce the time students await training in order to reduce the overall cycle time for training aviators. It uses lean principles and the Enterprise Strategic Analysis and Transformation framework (Nightingale, Stanke and Bryan 2008) to analyze the current state of the enterprise. A System Dynamics model examines the process view from the Enterprise Architecture reference framework to examine one course and simulate different courses of action to correct the problem. Finally, the thesis will present a proposed future state for the Flight School XXI Enterprise based on this analysis.

Enterprise Background

The Flight School XXI Enterprise is a training process that consists of several different individual courses that Army lieutenants and warrant officers attend to become combat aviators. In the last several years, a large "bubble" of students awaiting the different phases of training has developed. On any given day, over 700 students do not participate in any training at Ft. Rucker because they are awaiting a slot in a training course. With the current requirement to train 1200 students annually, Ft. Rucker has over six months of inventory they are not processing. Because of this, junior commissioned officers and warrant officers spend up to an extra year at Ft. Rucker for training. There are several impacts of this wait time on training at Ft. Rucker. First, aviator skills degrade between completing basic flying course and beginning the combat aircraft course. In addition, these young officers and warrant officers lose valuable time becoming certified aviators when they should be gaining experience in a combat unit. The bubble of students is a large concern for the leadership of the U.S. Army Aviation Center of Excellence and the Army.

The analysis identified several opportunities for improvement of the FS XXI Enterprise beyond solving the bubble problem. First, the elimination of identified enterprise wastes of waiting/delays, inappropriate processing, inventory, defects/rework, overproduction, and opportunity costs will be essential to improving the performance of the enterprise and the value deliver to stakeholders. Second, there is an opportunity to improve the metrics and processes to better align with the enterprise's strategic objectives. Also, there are opportunities to improve the interactions between the various organizations and stakeholders that make up the FS XXI Enterprise. Finally, there is an opportunity to improve the effectiveness and efficiency of the individual processes of training aviators.

System Dynamics Model

System Dynamics is an approach to understand the dynamic complexity that exists within systems, simulate the behavior of systems over time, adjust individuals' mental models of the system, and implement policies to improve the system. This thesis uses System Dynamics as a tool to better understand and simulate the process of training aviators in the AH-64 Advanced Aircraft Course. The AH-64 Advanced Aircraft Course trains new aviators on the operation and tactical employment of the AH-64 Apache attack helicopter. The course consists of several phases: transition, instruments, day systems, night and night vision goggles, gunnery, and advanced combat skills. The FS XXI Enterprise should be able to schedule courses to maximize throughput and efficiently utilize the enterprise's resources utilizing traditional project management tools. However, several feedback loops influence the course that demonstrates how the organization, policy/external influences, strategy, knowledge, and product views influence the process.

The model of the AH-64 Advanced Aircraft course uses System Dynamics as a tool to simulate the interactions between the process view and the other views of an enterprise. The intent of the model is to simulate the AH-64 course for 3 years (156 months) to determine how a bubble developed and what causes the course delays. To calibrate the model, the initial simulation of the model extends the course length to about 25 weeks, which is consistent with the available data. Additionally, the model shows how the strategy, organization, knowledge, product, and policy/external factors enterprise views influence the process view. The model accounts for the feedback loops identified above and demonstrates how the views impact the process of training aviators.

The FS XXI Enterprise could take several possible courses of action to improve the performance of the AH-64 training process. These courses of action could include modifications to the process, organization, or strategy view of the enterprise. The purpose of these modifications is to stabilize the course length and create a constant flow of students through the system. The four courses of action are: 1) to increase the number of aircraft; 2) increase the number of instructor pilots; 3) increase the daily flight period; and 4) add weather days to the Program of Instruction (POI). Although none of the initial courses of action provided increased performance when the initial conditions represented current bubble levels, the process provided valuable insights to develop a combined course of action for implementation.

The recommended course of action is for the enterprise to add weather days and increase the daily flight hour window. In this simulation, the model simulates an additional five days for weather within the course, a five day buffer between courses, and increases the daily flight hour window to 3.5 hours. The results of this combined course of action were very positive as the course length remained constant at 22.4 weeks throughout the simulation and the number of students in the bubble did not change. Another benefit of this course of action is that it the USAACE can implement the course of action through internal policy changes.

Recommendations

This thesis presents four major recommendations based on the research to improve the effectiveness and efficiency of the Flight School XXI Enterprise's training processes. These recommendations include adopting a customer pull mentality to align production with demand from the Combat Aviation Brigades, decreasing the batch size for students in a class, establishing continuous flow of students by eliminating the bubble between the common core course and the advanced aircraft courses, and adding weather days to the Program of Instruction to stabilize the training process.

The concept of customer pull ensures that the enterprise will only produce the type and quantity of aviators needed by the Combat Aviation Brigades. The Aviation Force Structure provides the demand for aviators and the Flight School XXI Enterprise can align their training processes to this demand. The current force structure requires the enterprise to train 1498 total aviators per year broken down into 360 AH-64 pilots, 699 UH-60 pilots, 196 CH-47 pilots, and 243 OH-58D pilots.

By decreasing the batch size of students in the advanced aircraft courses, the enterprise can reduce the demand on critical resources. The enterprise can achieve continuous flow and utilize resources more efficiently by reducing the capacity of the advanced aircraft courses by 50% and beginning the classes every two week. This significantly reduced the number of aircraft required on a daily basis and reduced the volatility of the daily demand for aircraft. Also, by beginning all of the advanced aircraft courses every two weeks the enterprise eliminates the inherent wait time in the current value stream map as the common core course finishes every two weeks, but some advanced aircraft courses begin every four weeks.

By achieving continuous flow, the enterprise ensures that once a student begins the Flight School XXI process they do not stop training for more than two weeks. This decreases the impact that long wait time has on aviator skills which degrade over time. To accomplish this, the enterprise must first re-align the courses to ensure that the advanced aircraft courses begin every two weeks. Also, they must cancel three common core courses to reduce the current bubble between the common core course and the advanced aircraft courses.

The final recommendation focuses on achieving a stable process for training aviators by adding weather days to the Program of Instruction (POI). The current POI accounts for weather with a longer daily flight period than necessary. This allows the instructor pilots to make up about 0.6 flight hours every day or about one day of training per week. However, if weather affects 19.8 days or more, which is likely given the historical data, the instructor pilots are unable to complete training on time. The enterprise can alleviate the impact of weather by adding weather days to the POI. Additionally, the enterprise should extend the flight hour window from 3 hours per day to 3.5 hours per day. A probabilistic model of the course with these changes indicated that the enterprise would complete the course on schedule 99.4% of the time, compared to 59% of the time without the additional weather days.

Conclusion

This thesis applied an eight view Enterprise Architecture reference framework, principles of lean thinking, and System Dynamics to the U.S. Army Aviation Center of Excellence's Flight School XXI Enterprise. These tools and methodologies provided a basis for recommendations to reduce the time students await training in order to reduce the overall cycle time for training aviators. The thesis identified the underlying causes of delays in training aviators that created the large bubble of students awaiting training. A System Dynamics model of the training process for the AH-64 advanced aircraft course provided valuable insights into the causes of these delays in training. The model identified weather and the student-to-instructor pilot ratio as two key causes of delays to the training course. The impact of these delays decreased the number of students that the enterprise could train and created the bubble of students awaiting training. The thesis then used these insights to determine how to stabilize the training process, develop a future state architecture, and prescribe an implementation plan to reduce the bubble of students and achieve the future state.

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Chapter 1: Introduction

This research applies the principles of Enterprise Architecture and Lean Enterprise Value to the U.S. Army Aviation Center of Excellence's Flight School XXI Enterprise. The primary research objective is to determine how to reduce the time students await training in order to reduce the overall cycle time for training aviators. The research involved the use of lean principles to analyze the current state of the enterprise, the process view of the enterprise architecture to examine one course, and system dynamics to model different courses of action to correct the problem. Finally, the thesis presents a proposed future state for the Flight School XXI Enterprise based on this analysis.

1.1: Background

The Flight School XXI (FS XXI) Enterprise is a training process that consists of several different individual courses that Army lieutenants and warrant officers attend to become combat aviators. In the last several years, a large "bubble" of students awaiting the different phases of training has developed. On any given day, over 700 students do not participate in any training at Ft. Rucker because they are awaiting a slot in a training course. With the current requirement to train 1200 students annually, Ft. Rucker has over six months of inventory they are not processing. Because of this, junior officers and warrant officers spend between 1 and 2 years at Ft. Rucker during training, which should only take approximately one year (Dinges 2009). There are several impacts of this wait time on training at Ft. Rucker. First, aviator skills degrade between completing basic flying course and beginning the combat aircraft course. In addition, these young officers and warrant officers lose valuable time becoming certified aviators when they should be gaining experience in a combat unit. The bubble of students is a large concern for the leadership of the U.S. Army Aviation Center of Excellence (USAACE) and the Army and several efforts have begun to address this problem.

1.1.1: Enterprise Description

The USAACE is the training organization for U.S. Army Active Duty and National Guard aviators for both fixed wing and rotary wing aircraft, located in Ft. Rucker, Alabama. The

USAACE enterprise comprises all U.S. Army fixed and rotary wing aviator training programs; Aviation officer, warrant officer, and enlisted training; as well as newer training programs for unmanned aerial vehicle (UAV) operators. In particular, the FS XXI Enterprise conducts initial rotary wing aviator training and controls the instructor pilots and training infrastructure required. Separate organizations at Fort Rucker are responsible for the welfare and administrative support of the trainees, logistics and maintenance of the airplanes, helicopters and UAVs, and maintenance and scheduling of the simulators that support training; however, they are all stakeholders in the FS XXI Enterprise. The Army currently tasks the USAACE with training over 1200 aviators per year. This training requirement will increase to 1498 by fiscal year 2010 because of the increased demand from operations in Iraq and Afghanistan as well as an increase in the number of aviation units (USAACE 2008).

The current training program for Rotary Wing Aviators is the FS XXI Enterprise that consists of several phases of training. There is an initial training phase, in which pilots learn basic skills during the following courses: Survival, Evasion, Resistance, and Escape (SERE); Junior Officer Professional Development (JOPD), and Helicopter Overwater Survival Training (HOST). In a second phase, students learn basic aviator skills in a civilian helicopter. The third phase of the training consists of training in combat aircraft (USAACE 2009).

1.1.2: Flight School XXI Objectives

The USAACE recently updated their objectives and created six major objectives with several sub-objectives each. Four of their major objectives directly impact FS XXI along with the relevant sub-objectives (USAACE 2009).

1. Achieve & sustain student throughput requirements
   a. Achieve & sustain student throughput requirements
   b. Ensure simulator support for requirements
   c. Synchronize accessions inputs to align with Structure and Manning Decision Review (SDMR) requirements
   d. Implement Aviation & Missile Command (AMCOM) fleet sustainment to support requirements
2. Support Combat Aviation Brigade's (CAB) Army Forces Generation (ARFORGEN) Readiness Requirements

    a. Support CAB's home station ARFORGEN training requirements
    b. Implement and synchronize the aviation enterprise process
    c. Execute and sustain the training and standardization enterprise effort
3. Synchronize and Integrate USAACE Resource Requirements
    a. Synchronize and integrate USAACE Military Construction (MILCON) to support FY12 student throughput requirements
    b. Implement an enterprise scheduling system (GTIMS)
    c. Implement garrison support plans to support FY12 student throughput requirements
4. Enhance Professional Military Education (PME)

The USAACE's updated strategic objectives are much more appropriate for a lean enterprise. Several of the new objectives focus on integrating, synchronizing, and sustaining new processes and resource management approaches. Also, the new objectives take into account all stakeholders as they include objectives to enhance the Professional Military Education, which focuses on the employees of the enterprise. However, the new objectives only focus on achieving the new student throughput, not delivering quality, trained aviators to the customer.

1.2: Motivation

The Commanding General of Ft. Rucker and the USAACE, MG James Barclay views the challenges the FS XXI Enterprise currently faces as an opportunity to improve years of inefficient processes. His view of the challenge provides the motivation for this thesis and the effort of the USAACE staff.

> *"The Big Opportunity is the transformation of Army Aviation and supporting Activities into an organization that is focused on training and generating relevant Aviation Forces to meet the constantly changing needs of the US Army.*
>
> *Eliminate 50 years of historical inefficient processes and organizational inertia. Over the next two years create a mindset where a new sense of optimism, mission accomplishment, and accountability emerge.*
>
> *This is a dramatic change in both ideas and practice."* (Barclay 2009)

MG Barclay's support for change is essential to this thesis and the enterprise transformation effort. As the leader of the USAACE, he has recognized the importance of the opportunity to improve the FS XXI Enterprise. Additionally, his emphasis on improving the training process at Ft. Rucker provides the necessary support to generate ideas for improvement and the support necessary to implement these changes.

1.2.1: Global War on Terrorism

Since September 11th, 2001 the U.S. Army has been fighting two wars in separate countries which has required soldiers to deploy multiple times placing stress on the Army's personnel management systems. This is especially true in highly skilled jobs, such as combat aviators, because there are a limited number of these high-skills, high-demand soldiers and the process for training them is lengthy. In a recent visit to the U.S. Army Aviation Center of Excellence, the Secretary of Defense emphasized this point in his comments to the USAACE leadership.

> *"We will also spend $500 million more in the base budget than last year to increase our capacity to field and sustain more helicopters - a capability that is in urgent demand in Afghanistan. Today, the primary limitation on helicopter capacity is not airframes but shortages of maintenance crews and pilots. So our focus will be on recruiting and training more Army helicopter crews."* (Gates 2008)

FS XXI is an integral part of the training process that produces the aviators required to fly in combat operations. The current process is not efficiently utilizing valuable resources or producing the required number of aviators to support the combat aviation brigades. Additionally, hundreds of young officers and warrant officers are awaiting basic aviator training when they could be training for combat with the CABs or gaining experience in combat. The importance of delivering a quality aviator to the CABs in a timely and efficient manner provides motivation for improvements to the current FS XXI Enterprise.

This challenge also presents an opportunity to expand the application of lean thinking to training within the military. The USAACE is not alone in the mission to train additional soldiers since September 11th. The military has the potential to make dramatic improvements to the efficiency of their training processes by utilizing lean thinking. Generally, military training is very resource intensive and should be, given the nature of the military's mission; however, it may be possible to train with the same level of intensity while utilizing resources more efficiently. The initially reaction of the warfighter may be to reject lean thinking for a fear that the intensity of training will be reduced. However, with an understanding of lean thinking and the elimination of waste they will realize that the goal is not to eliminate training for the sake of eliminating something, but to eliminate actions that do not create value. If the USAACE adopts lean thinking and principles for training aviators, the potential for these principles to spread to other Army training installations exists and this could benefit the entire Army.

1.2.2: Flight School XXI Challenges

During discussions with the Deputy Commanding General, USAACE Leadership, and the FS XXI Team, they identified several challenges as the principal issues facing the enterprise. First, the Army increased the training requirement from a throughput of 1200 students to 1498 by fiscal year 2012. Another challenge is that the increased throughput requires Army resourcing of additional Instructor Pilots and Aircraft that are not currently available to FS XXI Enterprise. Another challenge is that the enterprise must operate within the current budget, defend projected budgets, and gaining support for unfunded projects as they compete with other training centers of excellence for limited resources. To combat these future challenges, the FS XXI Enterprise should have a robust, scalable, flexible, and adaptable architecture to continue to meet performance requirements from the Army (McManus, et al. 2007). These characteristics form the criteria for evaluating the future state of the enterprise in Chapter 5.

The enterprise processes must be robust in that internal or external influence, such as weather or maintenance, should not impact performance. Additionally, the FS XXI Enterprise must have a scalable architecture to adjust throughput for possible increases or decreases in demand based on unknown future Army Force Structures. To support this changeability, the USAACE must re-write the contracts for maintenance and the IERW Common Course training to include adaptable contracts to adjust for increased or decreased demand. The FS XXI Enterprise must be flexible by being prepared to change their Program of Instruction (POI) to ensure compatibility with operational Army's fleet of aircraft as the Army purchases new types of aircraft. Finally, they must have an adaptable POI to incorporate lessons learned from their instructor pilots who recently served as combat aviators in Iraq and Afghanistan.

1.3: Organization of Thesis

This thesis contains six chapters: Introduction, Literature Review and Research Methods, Current State of the Enterprise, Process View of the Enterprise, Future State of Enterprise, and the Conclusion and Recommendations. The literature review includes a review of the current literature on Enterprise Architecture, Lean Thinking, and Stakeholder Theory. Within Chapter 2, the section on research methods discusses the survey and interviews utilized to gain an understanding of the enterprise and the data collection from different sources at the USAACE. The Current State of the Enterprise includes an analysis of the enterprise utilizing the Enterprise Strategic Analysis (ESAT) reference framework. The fourth chapter examines the enterprise through the Process View utilizing System Dynamics as a tool for modeling policy changes to the AH-64 Advanced Aircraft Training Course. The chapter on the Future State of the Enterprise presents a proposed future state for the FS XXI Enterprise based on conclusions and analysis in the previous chapters. The final chapter includes a conclusion of the findings and recommendations for future work.

Chapter 2: Literature Review and Research Methods

This chapter presents a review of the current literature on Enterprise Architecture which provides a reference framework for the analysis conducted in this thesis and the research methods utilized. It also presents a detailed description of the theory behind Enterprise Architecture to include a description of eight Enterprise Architecture views. Additionally, the chapter reviews the ilities that can improve the performance of the enterprise. Also, it presents methods to determine the alignment of the enterprise with the values of the enterprise stakeholders. It includes a discussion on lean thinking and lean enterprise value which provided valuable insights into understanding and analyzing the process of training aviators in this research. The chapter also discusses stakeholder theory and provides methods to identify and analyze stakeholders. Finally, the chapter summarizes the research methods utilized to gather information and data for the thesis.

2.1: Enterprise Architecture

Enterprise Architecture is an emerging field that applies holistic thinking to the design of enterprises as systems. Nightingale and Rhodes initially described Enterprise Architecture as "a new strategic approach which takes a systems perspective, viewing the entire enterprise as a holistic system encompassing multiple views such as organization view, process view, knowledge view, and enabling information technology view in an integrated framework" (2004). In this work, they view enterprises as complex, integrated systems that are inseparable from their environment. One cannot separate a supply chain from the manufacturing process as they are co-dependent on each other to successfully operate (Nightingale and Rhodes 2004). Because of these interdependencies, an architect must view enterprise systems holistically and optimize at the system level, not in a traditional silo manner. In the example of a simple manufacturing enterprise, the value stream takes raw materials and transforms them into goods for sale. If they only optimized the manufacturing process, the overall value chain might not be optimal as the delivery sub-system may not be able to deliver goods as fast as manufacturing produces them. So, to optimize the entire system, a holistic view of the enterprise with several lenses is required. Over the last several years, Nightingale and Rhodes have refined the views to include: strategy, policy/external factors, organization, process, knowledge, information, product, and services (Rhodes, Ross and Nightingale 2009).

2.1.1: Definitions

An essential element of understanding the enterprise architecture reference framework is specifying how the framework defines each term. Nightingale and Rhodes have refined their definition of Enterprise Architecture as "applying holistic thinking to conceptually design, evaluate, and select a preferred structure for a future state enterprise to realize its value proposition and desired behaviors" (2007). In addition to understanding the definition of Enterprise Architecture, one must understand the terms "enterprise" and "architecture".

An enterprise is "one or more persons or organizations that have related activities, unified operation or common control, and a common business purpose" (Black's Law Dictionary 2009). Rouse proposed thinking of an enterprise as a system or system of systems and defined an enterprise as "a goal-directed organization of resources—human, information, financial, and physical—and activities, usually of significant operational scope, complication, risk, and duration" (2005). He goes on to state that generally enterprise share the same goals of growth, value, focus, change, future, knowledge, and time. Additionally, he proposes that models and scientific tools can evaluate the performance of an enterprises' as-is and to-be states (Rouse 2005). Nightingale and Rhodes define an enterprise as "complex, highly integrated systems comprised of processes, organizations, information, and supporting technologies, with multifaceted interdependencies and interrelationships across their boundaries" (2004). Although these are all very broad definitions of enterprises, they provide a common frame of reference for what is meant by "enterprise".

Maier and Rechtin describe a system's architecture as a description of "whatever aspects of physical structure, behavior, cost, human organization, or other elements are needed to clarify the client's priorities" (2002). In their view, an architect is an agent of the client who works with the client and the builder on problem and solution definition to generate system requirements. Also, architecture is more an art than a hard science as the architect must rely on experience and heuristics, in addition to science and standards, to develop solutions that address non-analytic, immeasurable, or less understood problems (Maier and Rechtin 2002). Enterprise Architecting fits into this category of architecting, in which, the architect is dealing with complex, sometimes very ambiguous problems, where the use of traditional analytic tools may not be appropriate. Standards and frameworks for architecture, such as the Zachman Framework, Department of Defense Architecture Framework (DoDAF), IEEE-Std-1471-2000 Recommended Practice for Architectural Description of Software-Intensive Systems, all have their applications. However, these frameworks are separate from the reference framework Enterprise Architecture used in this thesis to analyze enterprise level systems (Nightingale and Rhodes 2004). Additionally, Enterprise Architecture differs from enterprise engineering in that in architecture the architect analyzes and designs the enterprise for value delivery. Whereas, in engineering the engineering systems drive the structure and function of the organization and the enterprise culture and structure can impact the system design (Allen, Nightingale and Murman 2004).

So, Enterprise Architecting is an approach for analyzing an enterprise level system and developing candidate architectures for the system. Nightingale and Rhodes utilize the eight views as a guide for the architect to perform enterprise architecture along with his experience and established heuristics to address complex, ill-defined problems (2007). However, it is not a rigid framework for design as it focuses on the art of architecting an enterprise and provides the architect with freedom to apply his judgment and experience to the problem.

2.1.2: Enterprise Architecture Views

In order to analyze an enterprise holistically, Nightingale and Rhodes have developed an eight view reference framework that includes the strategy, policy/external factors, organization, process, knowledge, information, product, and services views (Nightingale and Rhodes 2007). They break each of these views down further to understand the structure, behavior, artifacts, measures, and periodicity of each view (Rhodes, Ross and Nightingale 2009). With this framework, an enterprise architect gains a better understanding of the enterprise and can address the interdependencies in the system as they emerge. Table 2-1 presents the eight Enterprise Architecture Views and a description of each view.

View	Description
Strategy	Strategic goals, vision and direction of the enterprise including the business model; enterprise metrics and objectives
Policy/External Environment	The external regulatory, political and societal environments in which the enterprise operates
Process	Core leadership, lifecycle and enabling processes by which the enterprise creates value for its stakeholders
Organization	The organizational structure of the enterprise as well as relationships, culture, behaviors and boundaries between individuals, teams and organizations
Knowledge	The implicit and tacit knowledge, capabilities, and intellectual property resident in the enterprise
Information	Information needs of the enterprise, including flows of information as well as the systems and technologies needed to ensure information availability
Product	Product(s) developed by the enterprise; key platforms; modular vs. integral architectures, etc.
Services	Services(s) delivered and or supplied by the enterprise, including in support of products

Table 2-1: Enterprise Architecture Views (Rhodes, Ross and Nightingale 2009)

2.1.3: The ilities

As systems become more complex, non-traditional design criteria, collectively referred to as the "ilities", provide essential system properties and a method for evaluation. McManus, et al., defined these criteria as "system properties that specify the degree to which systems are able to maintain or even improve function in the presence of change" (2007). Although several of these criteria have emerged, they discussed eight ilities: Robustness, Versatility, Changeability, Flexibility, Adaptability, Scalability, Modifiability, and Survivability. These properties provide an opportunity to architect a system that will maintain performance despite changes to the external conditions. Also, the ilities are a basis for evaluating alternative architectures for an enterprise. The four ilities that are important to the Flight School XXI (FS XX) Enterprise are robustness, scalability, flexibility, and adaptability.

McManus, et al., defined robustness as "the ability of a system to maintain its level and set of specification parameters in the context of changing system external and internal forces" (2007). In this context, a robust system ensures that it continues to perform to specifications regardless of the external influences on the system. One can also define robustness in terms of value robustness, which means that a system continues to deliver value to its stakeholders as their needs change over time (Ross and Rhodes 2008). Stakeholders consider these value robust systems to be successful if the system continues to meet stakeholder needs over time without significant changes to the system. For this thesis, the first definition of a robust system provides a better criteria for evaluating alternative architectures as the FS XXI Enterprise must be able to produce pilots regardless of the external and internal forces on the system.

Scalability is "the ability of a system to change the current level of a system specification parameter" (McManus, et al. 2007). A system can scale in form, the number of students, or function, number of tasks trained at a reasonable cost to the enterprise. Ross, Rhodes, and Hastings developed a method to quantify this change ability and determine the scalability of a system. If the cost of scaling the system, increasing the number of students trained, is less than increase in utility then the system is scalable (2008). Again, this property will be important in developing a future architecture for the FS XXI Enterprise in the maximum number of students that can conduct training. With a scalable architecture, the enterprise will be able to increase the throughput of students without increasing the number of aircraft or simulators required to conduct training.

McManus, et al., defined flexibility as the "the ability of a system to be changed by a system-external change agent" where as adaptability is "the ability of a system to be changed by a system-internal change agent" (2007). The important difference between these two properties is the location of the change agent. Both of these properties provide potentially valuable attributes for the FS XXI Enterprise. The enterprise must be flexible in their ability to incorporate new aircraft into training. For example, if the Army adopts a new reconnaissance helicopter to replace the Kiowa, the FS XXI Enterprise must change to train aviators in the new aircraft. Also, the enterprise must have methods to adapt training based on lessons learned and the combat experience of their instructor pilots. As these pilots are internal to the system, this change would be an adaptable change.

2.1.4: Enterprise Alignment

The Enterprise Strategic Analysis and Transition (ESAT) Guide provides a method to determine the alignment of an enterprise's objectives, metrics, processes, and stakeholder values (Nightingale, Stanke and Bryan 2008). The X-Matrix (Figure 2-1) provides a tool to visualize the alignment of these aspects of the enterprise by assigning a strong or weak alignment between the different aspects of the enterprise. The upper left quadrant of the X-Matrix shows if the metrics are accurately evaluating the performance of the enterprise in relationship to the strategic objectives. The lower right quadrant evaluates the ability of the enterprise's metrics to accurately measure the key processes. The upper left quadrant shows how well the enterprise has aligned their strategic objectives with the stakeholder values. Finally, the lower left quadrant evaluates the alignment of the enterprise processes with the stakeholder value.

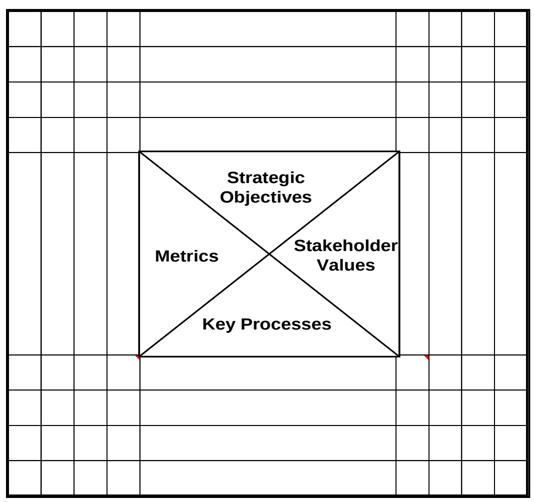

Figure 2-1: X-Matrix (Nightingale, Stanke and Bryan 2008)

2.2: Lean

This section presents the literature on lean thinking and the application of this thinking to enterprises. Womack and Jones brought lean thinking to the forefront with their book "Lean Thinking" which presented five lean principles for improving a business's performance (1996). This work presented several examples of successful implementation of the lean principles and a framework for applying lean thinking to any organization. Lean thinking focuses on two areas: delivering value to the stakeholders and banishing waste from the enterprise (Womack and

Jones 1996). Murman, et al., expand on this work in "Lean Enterprise Value" to apply lean thinking at the enterprise level (2002). A lean enterprise is "an integrated entity that efficiently creates value for its multiple stakeholders by employing lean principles and practices" (Murman, et al. 2002). These two works provide a basis for an understanding of lean thinking and a framework for applying lean principles to an enterprise.

2.2.1: Lean Thinking

Womack and Jones presented five principles of lean thinking: specify value, identify the value stream, flow, pull, and pursue perfection which provides a framework for transitioning to a lean enterprise (1996). Additionally, they outlined several types of waste that generally exist in an organization and methods to eliminate that waste. They also specify several lean terms such as: muda – waste; kaizen – continuous improvement; and kaikuku – radical improvement which are essential for understanding lean terminology (Womack and Jones 1996). They also discuss the lean enterprise as an integrated entity that includes the customer, production plant, and suppliers as components of the enterprise (Womack, Jones and Roos 1990).

The first two principles, specify value and identify the value stream, work together to determine how the enterprise delivers value to their customers. Womack and Jones define value as "a capability provided to a customer at the right time at an appropriate price, as defined in each case by the customer" (1996). At the enterprise level, stakeholders specify value through a value proposition, which is a combination of the individual stakeholder values. Generally, these value propositions formalize objectives, define relationships, and structures the enterprise to deliver expected value to all stakeholders (Murman, et al. 2002). With a specified value, a value stream map documents all of the processes required to deliver that value. A value stream map explicitly shows the way an enterprise carries out that actions that deliver value to the customer. Although the value stream map is an important tool for understanding the enterprise's current approach to delivering value, they are not a starting point for creating value (Murman, et al. 2002). A completed value stream map identifies actions required to design, order, and make a specific product and then sorts these actions into three categories: 1) actions that create value for the customer; 2) actions that create no value, but current system technology requires; and 3) actions that are of no value and should be eliminated immediately (Murman, et al. 2002). With the value stream map, one can determine the root causes of the waste and begin examining only the actions necessary for creating value to the customer.

The next principle, flow, focuses on the product and its needs, rather than the needs of the enterprise, a single machine, or a functional area so that all the necessary activities to design and produce a product occur in a continuous flow. The concept of flow goes against traditional batch-and-queue thinking; in which machines produce large quantities of material "to be efficient" and then this material moves to the next process to wait at the next step for processing. However, when the focus is on the product, batches always result in longer wait times as the product sits in a queue awaiting the next machine or waiting for the plant to changeover to the type of activity the product needs. Despite the fact that all of the workers appear busy in this system, the entire product is not busy because a majority of the product is waiting in some form of queue (Womack and Jones 1996). The ultimate lean process is the single-piece flow, which Womack and Jones describe as "a situation in which products proceed, one complete product at a time, through various operations in design, order-taking, and production, without interruptions, backflows, or scrap" (1996). While this is the ideal solution for flow in lean thinking, it is not always possible because of required buffers or limitations on resources. This is the case in the FS XXI Enterprise, where sending one student through the entire process would be infeasible because of the academic classes that accompany flight training. However, smaller batch sizes may prove beneficial as they have in other organizations. Womack and Jones have spent years benchmarking and observing the conversion of a classic batch-and-queue systems to continuous flow with outstanding results, such as reducing production throughput times by 90%, reducing inventories by 90%, and doubling labor productivity (1996). So, the benefits of smaller batch sizes are evident and the FS XXI Enterprise should consider smaller batches of students as a possible option.

The concept of pull is the ability to design, schedule, and make exactly what the customer wants, exactly when they want it. If an enterprise can achieve perfect pull from the customer, there is no need to generate sales forecasts or production schedules months in advance. The company can simply produce the product to order from the customer (Womack and Jones 1996). In addition to the benefit of less time spent generating forecasts, the company negates the risk of producing a product that the customer does not want. However, to achieve pull, the company must link their ordering processes linked to manufacturing so that they begin processing a customer order immediately. Also, they must have a single-piece flow manufacturing system so that they can produce the product for the customer with a very short throughput time. In the FS XXI Enterprise, this principle is not as important as the other principles are, because the Army has set a force generation schedule, which outlines exactly which brigades will be deploying and when, so FS XXI knows when to deliver new aviators. However, an essential part of this is ensuring that FS XXI's processes align with the Army's Force Generation (ARFORGEN) plan.

The final lean principle is to pursue perfection. The enterprise has not completed the lean transformation process when the final lean implementation project identified by the enterprise is finished. Along the path of implementation, the enterprise may identify additional waste which they can eliminate to further improve the enterprise. The enterprise should first agree on simple goals for transitioning to a lean enterprise, select a few projects to achieve these goals, allocate time and resources for these projects, and finally establish numerical targets for these projects (Womack and Jones 1996). Then, the enterprise can re-assess their current state and generate additional projects to continue to improve. Also, lean thinking is a continuous process of learning and capability building and the enterprise must invest in the workforce (Murman, et al. 2002). As the workforce learns lean principles and practices, they will begin to generate improvement ideas at the lowest level and the true benefits of lean thinking will emerge.

2.2.2: Lean Enterprises

Murman, et al., define a lean enterprise as "an integrated entity that efficiently creates value for its multiple stakeholders by employing lean principles and practices" (2002). A lean enterprise creates value by doing the right job and doing the job right. To accomplish this, they specify several principles for lean thinking at the enterprise level. First, in order to deliver value, an enterprise must first identify stakeholder value and construct a robust value proposition. Second, the enterprise must take a holistic approach to applying lean to ensure the enterprise is fully realizing the value of lean thinking. Also, the enterprise must address the interdependencies within the enterprise and ensure alignment across the enterprise to deliver value. Finally, the enterprise must realize that people, not just processes effect lean value, and are the key to eliminating waste and creating value (Murman, et al. 2002).

Murman, et al., categorize enterprise into three levels of enterprises to better understand the value propositions for each: program, multi-program, and national / international. A program level enterprise is a given set of activities that produce a particular product, system, or services that one must view as an interconnected whole. An example of this would be Boeing's 787 program which designs and produces one type of aircraft. A multi-program enterprise consists of multiple programs, which becomes much more complex because of the interdependencies between programs. An example of this would be Ford Motor Company, which has multiple programs, including commercial vehicles, consumer vehicles, and vehicle service. The highest level of enterprise is the national level, which is the expanded enterprise beyond the muti-program enterprise that includes all the enterprises that contribute to the creation of a type of product (Murman, et al. 2002). This would be an enterprise such as the defense industry, which is responsible for producing the nation's defense systems. The level of the enterprise is essential for understanding the value creation framework for the enterprise.

Murman et al., present a three phase value creation framework for understanding how an enterprise delivers value. The first phase is value identification, which includes identifying stakeholders and determining their needs and requirements for the enterprise. Also, this phase includes determining the stakeholders that have the greatest potential for both positive and negatives impacts on the enterprise. The second phase, value proposition, is when the needs of the stakeholders comes together to generate a combined value proposition. The object of this phase is to use stakeholder value propositions to structure the enterprise's value streams based on the stakeholders' value propositions. The final phase of the framework is value delivery, this is when and how the enterprise delivers the value to the customer (Murman, et al.

2002). Figure 2-2 presents this value creation framework. Also, Table 2-2 presents a description of the aims of the value creation framework for each of the enterprise levels.

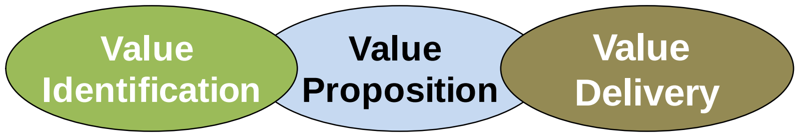

Figure 2-2: Value Creation Framework (Murman, et al. 2002)

Enterprise Level	I. Value Identification	II. Value Proposition	III. Value Delivery
Program Enterprise	Aim: Identify value-add opportunities for customers and end users; assess implications for other key program stakeholders	Aim: Construct a mutual gains agreement on value to be delivered among program acquirer, contractor, suppliers, and others; align incentives to focus on stakeholder value	Aim: Implement lean principles and practices across the value stream – including product development, manufacturing, and sustainment
Multi-Program Enterprise	Aim: Identify value-add synergies across programs; assess implications for internal and external stakeholders – including strategic partners, the financial community, and others.	Aim: Construct mutual gains agreements to develop current and future capabilities across the enterprise; align enterprise incentives to prevent suboptimization across programs.	Aim: Align enterprise support systems to enable lean implementation across multiple value streams – including information systems, financial systems, human resource systems and others.
National and International Enterprises	Aim: Identify incremental and breakthrough opportunities to advance core enterprise missions.	Aim: Establish overall system incentives to ensure stability and foster innovation simultaneously.	Aim: Establish a flexible, robust institutional infrastructure oriented toward ensuring current and future capabilities.

Table 2-2: Value Creation Framework for Enterprise Levels (Murman, et al. 2002)

2.2.3: Waste

Waste is "any human activity which absorbs resources but creates no value" (Womack and Jones 1996). Murman, et al., identified seven types of waste that generally appear in enterprises: overproduction, inventory, movement, waiting time, processing, rework, and transportation (2002). These types of waste provide opportunities for improvement as an enterprise can generally eliminate these wastes without sacrificing value. However, just eliminating waste should not be the focus of a lean enterprise, which should focus instead on delivering value before eliminating waste (Murman, et al. 2002). The Enterprise Strategic

Analysis and Transformation (ESAT) tool provides additional insight into enterprise level waste and specifies additional types of waste. In addition to the types of waste identified by Murman, et al., the ESAT identifies potential sources of waste including inappropriate processing, defects / rework, over production, structural inefficiencies, and opportunity costs (Nightingale, Stanke and Bryan 2008).

2.3: Stakeholder Analysis

An understanding of an enterprise's stakeholders is essential to analyzing the value proposition and value delivery of the enterprise. Freeman initially defined a stakeholder as "any group or individual who can affect or is affected by the achievement of the organization's objectives" (1984). Freeman proposes that traditional management views focused internally on the firm and its shareholders. This narrow view of the enterprise fails to account for the interests of all of the stakeholders who are essential to the enterprise's success and creates an environment where management focuses on shareholders' interests at the expense of employees, partners, etc. His framework for managing for stakeholders asserts that a business succeeds by delivering value to all of its key stakeholders and that the primary concern should be the interests of these stakeholders and the relationships between them (Freeman, Harrison and Wicks 2007).

Stakeholder analysis includes three major steps for indentifying stakeholders, determining their importance to the enterprise, and determining the value gained by the individual stakeholders. During the identification step, one analyzes the enterprise to determine the groups whose values are affected by the enterprise. The second step ranks the stakeholder by their importance to the enterprise, or their saliency which is composed of their power, legitimacy, and urgency (Mitchell, Agle and Wood 1997). Finally, one can determine the stakeholders' values through interviews or surveys to understand what individual stakeholder groups gain from their interactions with the enterprise.

2.3.1: Stakeholder Identification

The first step in stakeholder analysis is the identification of the key stakeholders in the enterprise. However, one of the key issues in current stakeholder theory is determining exactly who is a stakeholder in an enterprise. One could confine an enterprise's stakeholders to just those who are essential for the achievement of corporate objectives, or take a broad approach to include any stakeholders who the enterprise affects or could affect (Friedman and Miles 2006). This presents a problem because one must find a balance between identifying enough stakeholders to ensure the enterprise is delivering sufficient value to its stakeholders, but not so many as to make analysis almost impossible. Although every enterprise has their own unique stakeholders, several common categories of stakeholders appear in most enterprises. These include customers, the end users, shareholders, employees, unions, business partners, suppliers, and society (Murman, et al. 2002). Figure 2-3 presents a graphical depiction of the typical enterprise level stakeholders.

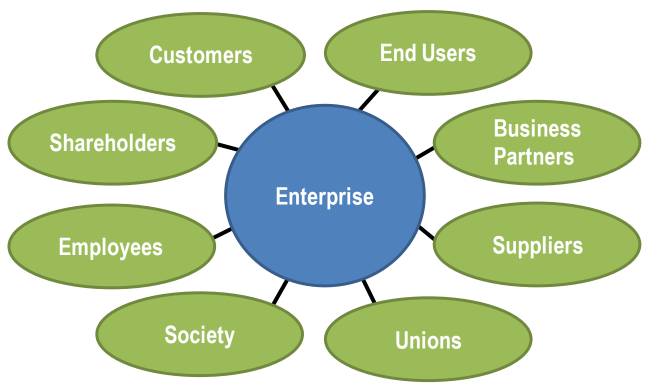

Figure 2-3: Enterprise Stakeholders (Murman, et al. 2002)

Murman, et al., defines customers as those who the enterprise delivers products or services to in exchange for revenue (2002). They differentiate this group of stakeholders from the end user in that the end users are the ones who actually use the product or services. This difference is a result of their background in defense and aerospace, where the customer who purchases the product, such as an airline purchasing an airline, is different from the end user, the pilot who flies the aircraft. In some enterprises, the customer and end user can be the same person; however, it is important to separate these two groups in some enterprises because they may have different values (Murman, et al. 2002).

The shareholders are the owners of the enterprise who provide capital to the enterprise and expect a return for their investment (Murman, et al. 2002). Traditional management theory, which places shareholders at the center of the enterprise's focus, asserts that the enterprise should place the interests of the shareholders ahead of customers, suppliers, and employees. However, this shareholder centric view of stakeholders prevents the firm from delivering value to all stakeholders to improve the performance of the enterprise (Freeman, Harrison and Wicks 2007).

The employees are the workforce who produce the products or deliver the services that an enterprise provides to its customers. These workers have their own values, both intrinsic and extrinsic, that they gain from working with the enterprise (Freeman, Harrison and Wicks 2007). The employees are an essential component of the enterprise, especially during times of change when their support is necessary for a successful transformation. Unions are the employee's representatives to management and should share the same values as the employees. However, they have their own governance rules and regulations, so it is important to separate their values from the values of the employees (Murman, et al. 2002).

An enterprise's business partners contribute to the value delivery process by providing additional capital, assuming some operational risk, and providing intellectual property (Murman, et al. 2002). These business partners are becoming more important as enterprises become global enterprises that operate in and deliver products to several different countries with different cultures. Although suppliers could become business partners, especially in a truly lean enterprise, suppliers remain a separate category of stakeholder. A supplier provides the necessary components or sub-assemblies for an enterprise to build their product or provide their service (Murman, et al. 2002). Suppliers are becoming more important as key stakeholders in any enterprise as supply chains become interconnected and businesses incorporate suppliers into their design process. The traditional view of suppliers as just a provider of stuff is no longer sufficient as businesses transition into leaner, more value driven enterprises (Freeman, Harrison and Wicks 2007).

The final category of stakeholder Murman, et al., identified is society. Today an enterprise must remain focused on the environment, providing and maintaining job opportunities, support the tax base, and be a positive force in the community (Murman, et al. 2002). Enterprises who fail to support society face scrutiny in the media with potentially devastating effects. Additionally, regulations and laws regarding the environment have the ability to devastate an enterprise. Likewise, companies that society views as having a positive influences can potentially reap the rewards of good press and a positive image. So, society can have a large impact on an enterprise's performance although they do not directly contribute to the value delivery process.

2.3.2: Stakeholder Saliency

Mitchell, Agle, and Wood identified a shortcoming in stakeholder theory in that no theory to that point provided a systematic method for identifying stakeholders and determining their saliency to the enterprise (1997). They proposed three factors for determining the saliency of a stakeholder: urgency, power, and legitimacy. Using these three attributes one can categorize stakeholders into eight groups. Figure 2-4 presents the stakeholder topology and the different categories of stakeholders (Mitchell, Agle and Wood 1997). Grossi expanded on these saliency factors and developed a method to quantify each stakeholders' criticality, power, and legitimacy factors to determine an overall saliency index for ranking stakeholders (2003).[1]

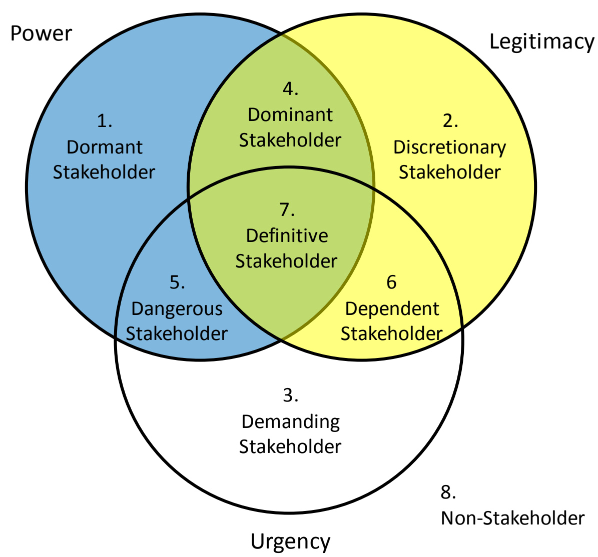

Figure 2-4: Stakeholder Topology (Mitchell, Agle and Wood 1997)

[1] Grossi substituted criticality for urgency in his work

The first saliency factor is the urgency factor and represents the time sensitivity a stakeholder has towards their stake in the enterprise. Mitchell, Agle, and Wood define urgency as "as the degree to which stakeholder claims call for immediate attention" (1997). They recognized that in addition to power and legitimacy, enterprises respond to stakeholders who have an urgent need for the value delivered by the enterprise. Urgency exists when two attributes are present: a time-sensitiveness of the stakeholder for the enterprise to address their claim and the importance of the claim to the stakeholder. Grossi renamed this factor as the criticality factor and developed a method for measuring a stakeholder's criticality based on the urgency and importance (2003). Table 2-3 presents his framework for measuring the criticality factor.

Criticality Factor	**Level description**	**Level Range**
Urgency	The stakeholder is time insensible or has very low demands for a timely response to its claims at risk in the enterprise	0-2
	The stakeholder asks for its stakes or values with enough anticipation allowing the enterprise to attend them in a timely manner	2-4
	The stakeholder requires attention to its stakes in plausible or reasonable times	4-6
	The stakeholder calls for a prompt attention to the stakes at risk in the enterprise	6-8
	The stakeholder demands immediate attention to the stakes it compromise in the enterprise and their associated payoffs	8-10
	Urgency Level	
Importance	The stakeholder has null or very low dependency on the stakes it puts at risk in the enterprise	0-2
	The stakeholder shows low dependency on the values obtained from the enterprise	2-4
	The stakeholder relies on the values obtained from the enterprise for its future actions or operations	4-6
	The stakeholder shows high dependency on the stakes it contributes at risk in the enterprise	6-8
	The stakeholder demonstrates very high dependency on the stakes it puts at risk in the enterprise and on the values obtained from it	8-10
	Importance Level	
	Criticality Attribute (Weighted) Average	

Table 2-3: Stakeholder Criticality Factor Determination (Grossi 2003)

The next saliency factor is the power factor which represents the stakeholder's power to control and influence the enterprise. This factor appears in the literature as one of the original aspects of stakeholder theory because it is one of the easiest factors to recognize. Mitchell, Agle, and Wood describe a stakeholder having power "to the extent it has or can gain access to coercive, utilitarian, or normative means, to impose its will in the relationship" (1997).

Additional literature describes methods stakeholder utilize to exert their power on an enterprise by controlling the resources required to deliver value by either withholding resources or attaching usage constraints on the resources (Frooman 1999). Grossi used the ideas presented in this literature to develop a framework for quantifying a stakeholder's power factor based on their coercive, utilitarian, and symbolic attributes (2003). Table 2-4 presents this framework and a description of the levels of the attributes.

Power Factor	Level description	Level Range
Coercive	The stakeholder threatening position to obtain the outcomes desired from the integrated enterprise is null or very low	0-2
	The stakeholder uses threatening arguments to obtain the outcomes it desires from the enterprise	2-4
	The stakeholder is able to pose real threats regarding his claims on the enterprise	4-6
	The stakeholder is capable of using some elements of force, violence, or restraint to obtain benefits from the enterprise	6-8
	The stakeholder is determined and totally capable of using force, violence, or any other resources to obtain desired outcome from the enterprise	8-10
	Coercive Power Level	
Utilitarian	The stakeholder has null or very low control over the resources (material, financial, services, or information) used by the enterprise	0-2
	The stakeholder has some control over some of the resources used by the enterprise	2-4
	The stakeholder controls the use of some of the resources used by the integrated enterprise	4-6
	The stakeholder heavily administers significant number of the resources used by the enterprise	6-8
	The stakeholder extensively administers most of the resources used by the enterprise	8-10
	Utilitarian Power Level	
Symbolic	The stakeholder does not use or barely uses normative symbols (prestige, esteem) or social symbols (love, friendship, acceptance to influence on the enterprise system	0-2
	The stakeholder uses some level of normative symbols or social symbols to influence on the enterprise	2-4
	The stakeholder uses moderate levels of normative symbols or social symbols to influence on the enterprise system	4-6
	The stakeholder relies on normative symbols and/or social symbols to claim his stakes from the enterprise system	6-8
	The stakeholder extensively uses normative symbols and social symbols in order to obtain value from the enterprise system	8-10
	Symbolic Power Level	
	Power Attribute (Weighted Average)	

Table 2-4: Stakeholder Power Factor Determination (Grossi 2003)

The third factor for determining a stakeholder's saliency is the legitimacy factor which is the stakeholders accepted and expected role in the enterprise. Much of the literature states that there is a link between power and legitimacy in that these factors are dependent upon one another. However, Mitchell, Agle, and Wood propose that these factors can exist independently as stakeholders may have a legitimate claim in the enterprise but not have the power to influence the enterprise (1997). Table 2-5 presents Grossi's framework for determining a stakeholder's legitimacy.

Legitimacy Factor	Subtypes	Level Description	Level
Broad Definition		Generalized perception or assumption that the actions of a stakeholder are desirable, proper, or appropriate within some socially constructed system of norms, values, beliefs, and definitions	0-10
Pragmatic	Exchange Legitimacy	Extent to which the stakeholder maintains a materialistic (based on goods, services, or any other type of exchange) relationship with the enterprise, and the importance of those exchanges to the welfare of the enterprise system	0-10
	Influence Legitimacy	Extent to which the stakeholder helps in defining the strategic or long-term interests of the whole enterprise and its submission to those interests before its own welfare	0-10
	Dispositional Legitimacy	Degree to which the stakeholder is predisposed to share or adopt the enterprise values demonstrating honesty, decency, and trustworthiness in the relationship	0-10
		Pragmatic Legitimacy Average Level	
Moral	Consequential Legitimacy	Degree to which the accomplishments of the stakeholder are perceived by the whole enterprise system as "the right thing to do"	0-10
	Procedural Legitimacy	Extent by which the stakeholder's value creation processes are perceived as sound and good efforts to achieve some, albeit invisible, ends as valued by the enterprise system	0-10
	Structural Legitimacy	The degree by which the stakeholder is perceived as having the right internal organizational structure to perform its assigned role in the enterprise system	0-10
	Personal Legitimacy	Extent by which the leaders of the stakeholder organization are perceived as having the adequate charismas, personalities, and authority to perform the job the stakeholder is supposed to do for the enterprise system	0-10
		Moral Legitimacy Average Level	
Cognitive	Comprehensibility Legitimacy	Degree of existence of cultural models that provide plausible explanations for the stakeholder participation in an enterprise and its relative endeavors	0-10
	Taken-for-grantedness Legitimacy	Degree to which the legitimacy of the stakeholder is taken for granted without an explicit evaluative support	0-10
		Cognitive Legitimacy Average Level	
		Legitimacy Attribute (Weighted) Average	

Table 2-5: Stakeholder Legitimacy Factor Determination (Grossi 2003)

The final piece of determining a stakeholder's saliency is to combine the power, legitimacy, and criticality factors to determine the stakeholder saliency index. This index allows one to rank stakeholders according to their saliency utilizing both a standard and normalized index. The Stakeholder Saliency Index (SSI) provides an index based on a maximum score of 130 and the Normalized Stakeholder Saliency Index (NSSI) normalizes this score to a maximum of 100 (Grossi 2003).

$$SSI = \frac{\sqrt{3}}{4} x(Power\ x\ Legitimacy + Power\ x\ Criticality + Legitimacy\ x\ Power)$$

$$NSSI = \frac{1}{3} x(Power\ x\ Legitimacy + Power\ x\ Criticality + Legitimacy\ x\ Power)$$

2.4: Research Methods

In addition to the literature review, interviews with members of the FS XXI Enterprise provided a large portion of the research for this thesis. U.S. Army Aviation Center of Excellence (USAACE) documents provided information regarding the schedule of classes, Programs of Instruction (POIs), and regulations regarding flight operations and helicopter maintenance. USAACE reports, including the status of flight line and awaiting training report provided valuable data on the current performance of the enterprise. Appendix A consolidates this data and Chapter 3 presents an analysis of the data trends. In line with the ESAT, surveys and interviews of stakeholders proved to be a valuable source of information to determine their value proposition. Appendix B provides the results of these surveys and interviews, and Chapter 3 presents the analysis of these results. In addition to providing insights into the value creation, these surveys and interviews identified potential waste within the enterprise that they could potentially eliminate. The U.S. Army's Center for Army Analysis conducted an initial analysis of the FS XXI Enterprise, which provided a base of research and analysis to build upon. Finally, several trips to Ft. Rucker, which included additional interviews and observation of the training process, provided a deeper understanding of the FS XXI Enterprise.

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Chapter 3: Current State Analysis

This chapter presents an analysis of the current state of the Flight School XXI (FSXXI) Enterprise as a basis for the proposed future state. The Enterprise Strategic Analysis and Transformation (ESAT) framework provides a guideline for an analysis of the current state of the enterprise. Gaining an understanding of the current state is essential to developing a feasible future state and achievable transition plan for the enterprise. Stakeholder interviews and surveys, process mapping, research on current metrics, and evaluation of enterprise level waste provided the data for the analysis. The chapter concludes with the identification of opportunities for the enterprise to improve the alignment of metrics, interactions, and processes.

3.1: Enterprise Organization

FS XXI is a program level enterprise that is a component of the U.S. Army Aviation Center of Excellence (USAACE), a multi-program enterprise. Figure 3-1 presents the different levels of enterprises which affect Flight School XXI. It is important to understand the influences of the U.S. Army, the national level enterprise, because it controls funding, equipment distribution, and personnel allocation. Additionally, the other program level enterprises within the USAACE compete with FS XXI for resources such as training areas, funding, and personnel.

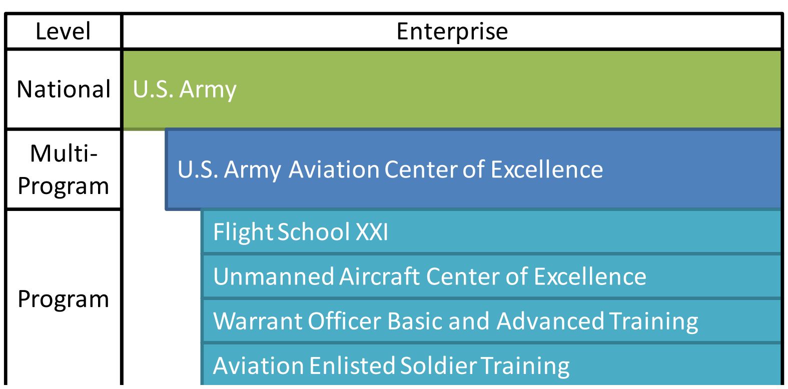

Figure 3-1: Enterprise Levels

The FS XXI Enterprise primarily consists of the 110th Aviation Brigade that directly controls the Instructor Pilots and is responsible for training students. However, there are additional stakeholders within the enterprise that are important to understand. Figure 3-2 presents the hierarchical organization of the stakeholders that influence FS XXI.

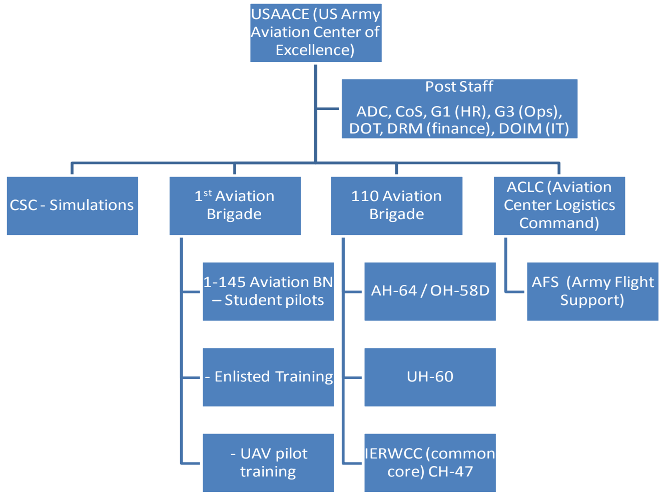

Figure 3-2: Organization of the USAACE

First, the Computer Science Corporation (CSC), a civilian contractor, controls the scheduling, operation, and maintenance of all aircraft simulators that are used for training. The 1st Aviation Brigade is responsible for the accountability of the students while assigned to Ft. Rucker. Aviation Center Logistics Command (ACLC) and Army Flight Support (AFS) are responsible for the maintenance of the aircraft used by the FS XXI Enterprise. Finally, the Post Staff control functions such as human resources, resource management, and budgeting.

3.1.1: Enterprise Resources

The two major resources for FS XXI are the instructor pilots, who train the students, and the aircraft in which the students train. Table 3-1 presents the total number of instructor pilots authorized for FS XXI and Table 3-2 presents the aircraft authorized for FS XXI.

Aircraft	Required (MIL/CIV)	Authorized (MIL/CIV)	Total
CH-47D	31/18	31/18	49
CH-47F	21/13	21/13	34
AH-64D	85/58	85/58	143
UH-60A	112/72	112/72	184
UH-60M	18/9	18/9	27
OH-58D	30/20	30/20	50

Table 3-1 Instructor Pilot Authorization for FY10 (USAACE 2008)

Aircraft	Required	On-Hand	Δ (based on FY12 Requirements)
CH-47D	36	24	- 12
CH-47F	12	12	0
AH-64D	88	60	- 28
UH-60A	96	79	- 17
UH-60M	12	12	0
OH-58D	38	36	- 2
TH-67 Contact	110	89	- 21
TH-67 Instrument	57	47	- 10
TH-67 BWS	52	47	- 5

Table 3-2: Aircraft Authorization (USAACE 2008)

3.1.2: Enterprise Costs

There are both direct and indirect costs associated with the operation of FS XXI. The direct costs of FS XXI include an annual operational budget of approximately $998M. However, this does not include the military pay associated with assigned personnel including the USAACE staff, instructor pilots, and students. Figure 3-3 presents the breakdown of the FS XXI operational budget.

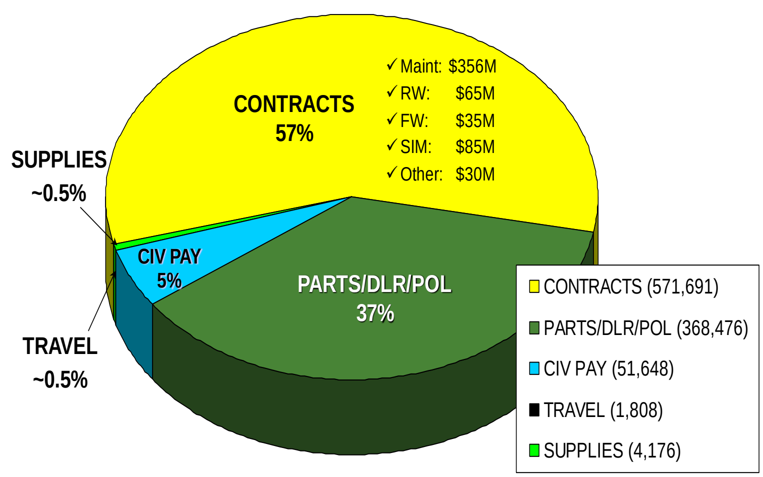

Figure 3-3: Enterprise Cost Breakdown (USAACE 2008)

Additionally, there are indirect costs associated with the time that students spend in the bubble not training or contributing to the Army. While students are awaiting training, the Army is paying their salary, but not receiving any benefit from the students. With the current size of the bubble, this cost totals about $35 million per year in salary and allowances. Although there is not a method to recoup these losses, by eliminating the bubble these students will not waste time at Ft. Rucker and be productive aviators for the Army.

Other costs associated with a large number of students awaiting training at Ft. Rucker are more intangible. First, there is a degradation of aviator skills between the different courses and during the time between training and arrival at their first duty station. Also, there is a significant decrease in morale and motivation as students wait months before beginning training. Finally, there are costs incurred when students develop legal issues that arise when they have too much free time, possibly resulting in separation from the Army.

3.2: Stakeholder Analysis

The first step in stakeholder analysis is to identify the different stakeholders who gain value from the enterprise and have influence on the enterprise. Then, surveys and interviews determine what the stakeholders value from the enterprise and how well the enterprise is delivering that value. Finally, any discrepancies between the value desired and delivered are opportunities to eliminate waste.

3.2.1: Stakeholder Identification

Grossi defines a stakeholder as "any group or individual who directly or indirectly affects or is affected by the level of achievement of an enterprise's value creation process" (2003). The organizational chart, in Figure 3-2, provided a basis for identifying the stakeholders of the FS XXI Enterprise. However, there are several sub-groups that are within the organization that important stakeholders, as well as groups outside the USAACE. Figure 3-4 presents FS XXI's stakeholders.

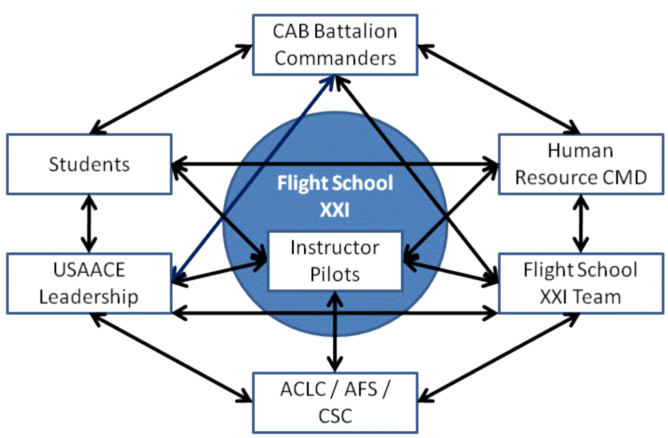

Figure 3-4: Flight School XXI Stakeholders

- **Combat Aviation Brigade (CAB) Battalion Commanders:** The “customers” of the FS XXI Enterprise who receive the newly trained aviators in both National Guard and Active Duty units throughout the Army. There are four major types of battalions in a combat aviation brigade, which require different types of aviators. General Support requires UH-60 and CH-47 aviators, Assault requires UH-60 aviators, and Attack / Recon require either AH-64 or OH-58D aviators (U.S. Army Aviation Warfighting Center 2008).
- **Human Resource Command (HRC):** The Army’s human resources department, they assign instructor pilots to the USAACE and are responsible for determining the number of officers and warrant officers who will attend FS XXI training.
- **US Army Aviation Center of Excellence (USAACE Leadership):** Control resources on Ft. Rucker, set the priorities for training, and determine the vision for the enterprise.
- **Aviation Center Logistics Command (ACLC) / Army Fleet Support (AFS):** Resource providers for the enterprise. ACLC is the military command responsible for the maintenance contract for the aircraft on Ft. Rucker. AFS, a civilian contractor, conducts the maintenance for the aircraft for training and supply the instructor pilots with the necessary resources for training (AFS 2009).
- **Computer Science Corporation (CSC):** Another resource provider for the enterprise. CSC, a civilian contractor, operates and maintains a fleet of aircraft simulators which are another essential resource for training (CSC 2009).
- **Flight School XXI Team:** Assist with the integration of all aspects of FS XXI and advise the USAACE leadership on improvements to the process.
- **Students:** This group of stakeholders is the officers and warrant officers who attend FS XXI training. Although the students are also the product of FS XXI, they are also an important stakeholder, similar to a health care enterprise.
- **Instructor Pilots:** These are the employees of Flight School XXI. They are responsible for actually training the students.

3.2.2: Stakeholder Value Comparison

Grossi's stakeholder saliency index provides a framework for determining the relative importance of the stakeholders to the enterprise. His framework evaluates stakeholders based on their power, legitimacy, and criticality attributes (2003). Table 3-3 presents the saliency index for the FS XXI Enterprise stakeholders and ranks them according to their importance to the enterprise. As one would expect in a military organization, the leadership has a very high power and legitimacy attribute, which causes their high ranking. One odd characteristic of this enterprise is the low ranking for the customer of the enterprise. In most enterprises, the customer has a significant amount of power because of their purchasing power and ability to change suppliers. However, in this enterprise, FS XXI is the only supplier of combat aviators and the CAB Battalion Commanders do not have control over their training. Another interesting aspect is the amount of power that the resource suppliers posses in the enterprise. The suppliers of the aircraft, AFS, and simulators, CSC, have a high utilitarian power attributes because they resources they provide are essential for the enterprise to accomplish their mission.

	Criticality Attribute			Power Attribute				Legitimacy Attribute				Saliency Index		
Stakeholder	Urgency	Importance	Criticality Average	Coercive	Utilitarian	Symbolic	Power Average	Pragmatic	Moral	Cognitive	Legitimacy Average	SSI	NSSI	Rank
CAB Battalion Commanders	8	10	9.0	5	2	5	4.0	3	8	8	6.5	52	40	4
Students	10	10	10.0	2	2	4	2.7	7	8	8	7.6	53	41	3
Instructor Pilots	8	5	6.5	6	8	8	7.3	6	10	9	8.2	70	54	2
Flight School XXI Team	5	5	5.0	4	2	10	5.3	7	8	8	7.8	46	36	6
USAACE Leadership	6	5	5.5	10	10	10	10.0	9	9	10	9.1	85	65	1
AFS / ACLC	4	4	4.0	8	10	6	8.0	6	6	9	6.8	49	38	5
CSC	4	4	4.0	8	10	6	8.0	7	6	8	6.9	50	38	5
HRC	2	6	4.0	5	4	6	5.0	5	5	8	5.7	31	24	7

Table 3-3: Stakeholder Saliency Index

Figure 3-5 presents the value comparison for the stakeholders of the enterprise. The stakeholder saliency index ranks the stakeholders along the X axis according to their importance to the enterprise. On the Y axis, data from the surveys determined an average level of value delivery to the stakeholder. For example, the FS XXI Team felt that the enterprise was not delivering value to them; therefore, they are lower in the chart.

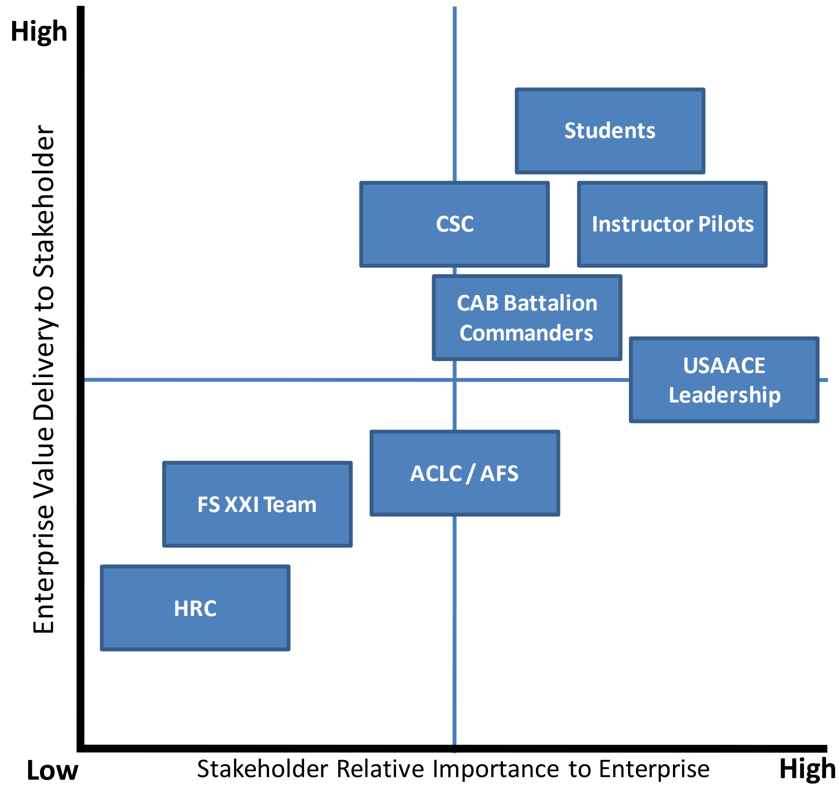

Figure 3-5: Stakeholder Value Comparison

3.2.3: Stakeholder Value Delivery

Surveys and interviews of the different stakeholder groups captured the stakeholder values and the enterprise's performance. Quality Aviator Produced is the quality of the product produced by the enterprise, the skills gained by the students and the amount of time that it takes a recent graduate to progress to a fully combat ready pilot. Efficient Use of Resources is the ability of the enterprise to utilize assigned resources. The value of Graduating Students on Time is the adherence to the course graduation schedule according to Ft. Rucker's White Book. Timeliness of Aviator Produced is the amount of time a pilot requires to complete the FS XXI training. The value of Professional Development includes opportunities to attend professional development courses while assigned to Ft. Rucker and lessons students learn from instructor pilots outside the prescribed program of instruction. A Predictable Work Schedule is the ability of enterprise members to have a reasonably know when and where they will be working. The value of Schedule Variance is the deviation from the scheduled and actual use of resources. Providing IPs with Quality Resources is the ability of resource providers to provide quality resources to instructor pilots for training on time and fully mission capable. The Quality of Training value is the quality of training received as perceived by the students. Professionalism of IPs is how well they not only train the students, but also how they develop them as Army Aviators. The Choice of Aircraft and Duty Stations value is the students' ability to choose their aircraft and first duty station. Finally, the value of Minimal Time at Ft. Rucker is student's desire to spend the least amount of time at Ft. Rucker.

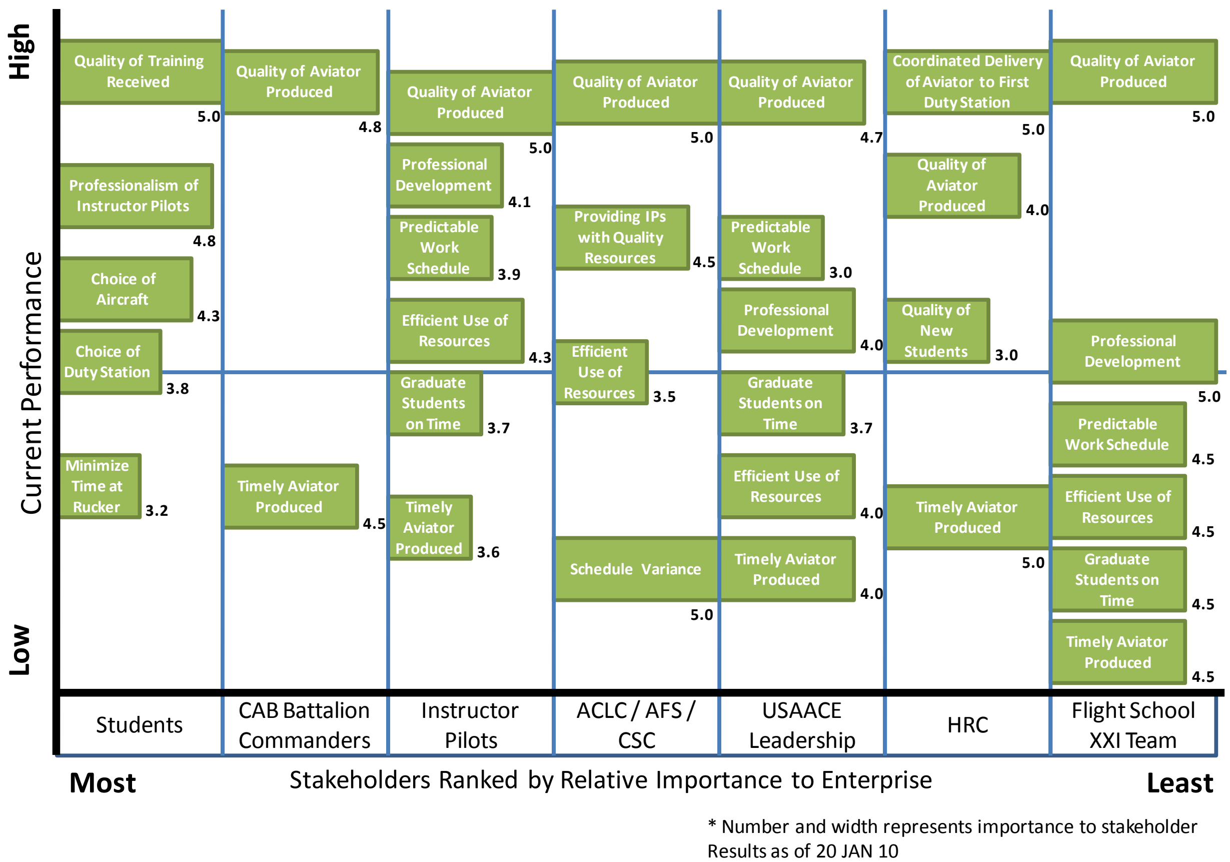

Figure 3-6: Value Importance and Delivery by Stakeholder

Figure 3-6 presents the importance of the stakeholder values and the enterprise's current performance delivering these values. The figure lists the enterprise stakeholders along the x-axis according to their importance to the enterprise. The figure plots the performance of the enterprise's value delivery along the y-axis. The width of the box containing the individual values and the numeric value corresponds to the importance of that value to the individual stakeholder. The importance of the value is rated on a scale from 1 to 5, 5 being very important. Appendix B provides individual value delivery charts for each stakeholder group.

All of the stakeholders rate quality of aviator as very important and feel the enterprise is delivering this value well. Students generally view the FS XXI Enterprise as highly delivering value. However, they feel the enterprise performs poorly at minimizing the time spent on Ft. Rucker (Students 2010). The CAB Battalion Commanders find that the timeliness of aviators produced is very important, with a rating of 4.5; however, the enterprise is poorly delivering timely aviators (Commanders 2010). The Instructor Pilots rate the performance of both the ability to graduate students on time and the timeliness of aviators produced as low; however, they do not find these values very important, with ratings of 3.7 and 3.6 respectively (Pilots 2010). The resource providers, Army Fleet Support and Computer Science Corporation, rate the enterprise as performing poorly in delivering the value of schedule variance. They rate these values as very important, at 5.0, but feel that the enterprise is not delivering on this value (AFS 2009) (CSC 2009). The Leadership of the USAACE also realizes that the enterprise is performing poorly at providing aviators in a timely manner. However, they also feel that the enterprise does not perform well at efficiently utilizing resources, which it rates just as important as producing aviators in a timely manner (Leadership 2010). The interview with an officer in the aviation branch of human resource command identified other values which are important based on their mission to manage all aviation personnel. They value providing the USAACE with quality lieutenants and warrant officers to become aviators and coordinating delivery of trained aviators to Combat Aviation Brigades. Because of these values, they rated timeliness of aviators produced as very important, but feel the enterprise is not delivering this value (Representative 2009). Finally, the Flight School XXI Team rated all of the values as important to very important, but felt the enterprise was not delivering value well for most values (FSXXI 2010).

3.2.4: Stakeholder Value Discrepancies

The largest discrepancy across stakeholders is between the importance and performance of the timeliness of aviators produced. Almost all of the stakeholders found this value to be important to very important; however, the enterprise is poorly delivering value. The enterprise also fails to deliver value in two other important areas: graduating students on time and efficiently using resources.

There are also a number of discrepancies between the perceived importance of values by different stakeholders. For example, Figure 3-7 shows how Battalion Commanders, the customer, feel that timeliness of aviators produced is very important; however, Instructor Pilots, the employees directly involved in delivering this value, do not view it as being very important. Without effective communication amongst stakeholders, discrepancies like this will be nearly impossible to correct.

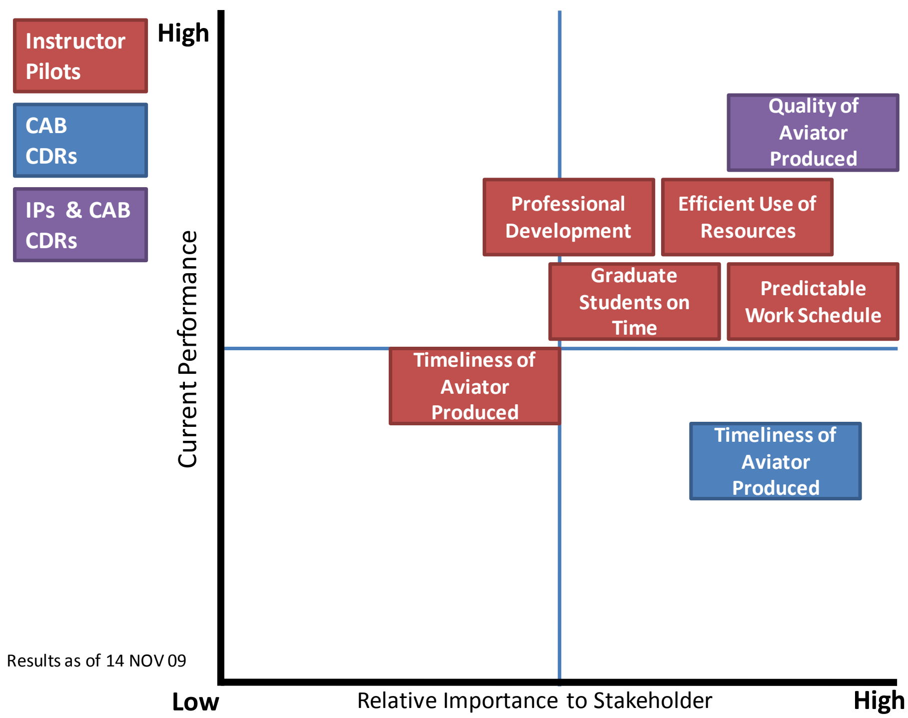

Figure 3-7: Value Discrepancy between Battalion Commanders and Instructor Pilots

Another important discrepancy between stakeholders, which the value delivery charts do not reflected, but was evident in the surveys, is between National Guard and Active Duty students. National Guard students place far more importance on reducing the amount of time spent on Ft. Rucker than their active duty counterparts because they generally have other careers and a family to return to in their home state. As a result, this value appears as being moderately important to the stakeholder.

3.3: Enterprise Processes

Several enterprise level processes are essential for delivering value to the customer. Figure 3-8 presents the current enterprise value stream map with the value added, no value added but necessary, and the no value added processes annotated. The value stream begins with the identification of rotary wing aviator trainees and ends with trained and qualified rotary wing pilots available for assignment to the CABs. As shown by the value stream map, the current system does not have a synchronized flow of students through the enterprise. There is an inherent two week gap between the end of the IERW Common Course and three of the Advanced Aircraft Courses. Additionally, because of an unbalanced flow, the system has generated bubbles between the different phases of training, in which students wait between 4 and 20 weeks to start the next phase of training. These bubbles add no value to the enterprise and are a huge driver of waste.

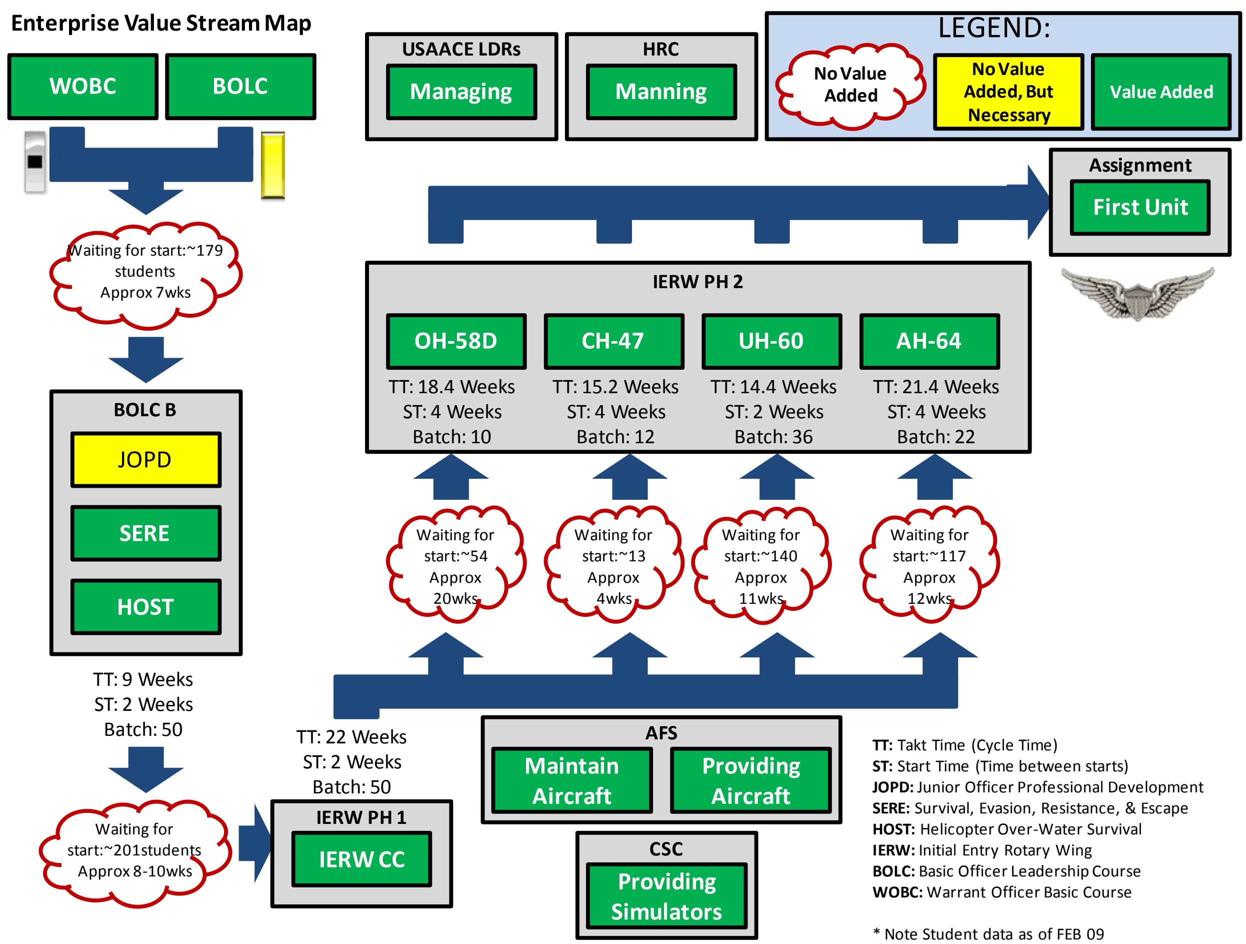

Figure 3-8: Current Enterprise Value Stream Map (Enos, et al. 2009)

3.3.1: Process Description

The individual courses that comprise the FS XXI curriculum are the main value-adding processes for the enterprise. This section describes these courses in detail to include the course length and capacity (ATRRS 2010).

- **Junior Officer Professional Development (JOPD):** The initial professional development training for warrant officers and lieutenants, JOPD emphasizes leadership, soldierization, common tasks, and combined arms tactics. (Length: 1 Week; Capacity: 50)
- **Survival, Evasion, Resistance, and Escape (SERE):** An intense physical and mental training program, which provides knowledge and skills for survival, evasion, resistance, and escape from captivity. It provides instruction and techniques for both individuals and teams during both classroom instruction and a field training experience. (Length: 3 Weeks; Capacity: 80)
- **Helicopter Overwater Survival Training (HOST):** This training teaches students the hazards to aircraft and personnel during overwater operations, operation of safety and survival equipment, pre-ditching, and evacuation procedures. Also, the course teaches students how to effectively use an Emergency Breathing Device to egress a ditched aircraft. (Length: 1 Weeks; Capacity: 50)
- **Initial/Emergency Rotary Wing Common Course (IERW CC):** Course designed to provide students with basic rotary-wing operator skills and knowledge for qualification in the TH-67 aircraft. Training includes physical and mental skills for basic rotary-wing flight maneuvers, emergency procedures, flight planning, instrument flight, and safety factors in preparation for qualification in advanced aircraft. (Length: 22 Weeks; Capacity: 50)
- **OH-58D:** Course designed to provide students with the necessary skills and knowledge required to become a qualified Army combat aviator in the OH-58D Kiowa Warrior aircraft. Training includes physical and mental skills for basic maneuvers, emergency procedures, flight planning, communication, operation of the mast-mounted sight, combat skills, night vision goggle training, gunnery, and additional skills required to fly a Kiowa Warrior in combat. (Length: 18 Weeks, 2 Days; Capacity: 10)
- **CH-47:** Course designed to provide students with the necessary skills and knowledge required to become a qualified Army combat aviator in the CH-47 Chinook aircraft. Training

includes physical and mental skills for basic maneuvers, emergency procedures, flight planning, communication, combat skills, night vision goggle training, and additional skills required to fly a Chinook in combat. (Length: 15 Weeks, 1 Day; Capacity: 12)

- **UH-60:** Course designed to provide students with the necessary skills and knowledge required to become a qualified Army combat aviator in the UH-60 Blackhawk aircraft. Training includes physical and mental skills for basic maneuvers, emergency procedures, flight planning, communication, combat skills, night vision goggle training, and additional skills required to fly a Blackhawk in combat. (Length: 14 Weeks, Capacity: 36)
- **AH-64:** Course designed to provide students with the necessary skills and knowledge required to become a qualified Army combat aviator in the AH-64 Apache aircraft. Training includes physical and mental skills for basic maneuvers, emergency procedures, flight planning, communication, operation of the fire control radar, combat skills, night vision goggle training, gunnery, and additional skills required to fly an Apache in combat. (Length: 21 Weeks, 4 Days; Capacity: 22)

3.3.2: Flight School XXI Process Metric Identification

Table 3-1 presents the metrics currently used by FS XXI to measure performance. While these metrics are measurable and have identified goals, they do not appear to drive specific decisions or change mechanisms. Rather, these metrics reflect the symptoms of process failure but they do not reflect how the problem occurred or trigger actions to correct the process.

Additionally, six separate reports contain the necessary metrics to measure the FS XXI process, which different organizations within the USAACE generate. 110th Aviation Brigade generates The Status of Flight Line (SoFL) report daily; 1st Aviation Brigade generates the Awaiting Training Report (ATR) on a bi-weekly basis; Army Fleet Support generates the Daily Aircraft Delivery Report (A/C Daily) and the Annual Aircraft Utilization report (A/C UTY); and the USAACE Staff generate the Command and Staff (C&S) and the White Book (WB). These disconnected reports generate huge amounts of waste in attempting to gain an accurate picture of FS XXI's performance.

Concept	Measurement	Report
Course Adherence to Schedule	# days behind (ahead)	SoFL
Training Schedule Variance	Cumulative hours deficient by class	SoFL
Number of Students Per Course	Number of Students	SoFL
Cumulative Graduates Per FY	Number of Students	C & S
Aircraft Availability/Needed for Training	% Aircraft Needs Met by Maintenance	A/C Daily
Course Start Deviation	Days Between Schedule & Actual Start	SoFL
Annual Planned Student Load	# of Pilots to Train	WB
Student Backlog (BOLC IIIB)	# Students on site, not training	ATR
Student Backlog (IERW CC)	# Students on site, not training	ATR
Student Backlog (AH-64)	# Students on site, not training	ATR
Student Backlog (UH-60)	# Students on site, not training	ATR
Student Backlog (OH-58D)	# Students on site, not training	ATR
Student Backlog (CH-47)	# Students on site, not training	ATR
Training Periods Lost to Weather	# Periods Lost	A/C UTY

Table 3-4: Current Process Metrics

3.4: Current Metric Analysis

The enterprise currently tracks how far behind courses are in hours and class days, the size of the "bubble" preceding each course, and the number of training days lost to weather. However, the enterprise does not have one organization that tracks these metrics, but rather multiple organizations report this information in nearly incomprehensible formats that vary across the enterprise. Often individual stakeholders only use these metrics internally and do not communicate them across the enterprise and when they do, they send the report as an e-mail attachment. For example, the 1st Aviation Brigade tracks a bi-weekly report of students in training, the bubble; however, they do not control course start dates or capacity to affect that metric. Also, the 110th Aviation Brigade tracks the progress of every FS XXI course in progress using a daily Status of Flight Line report. This report is difficult to comprehend, does not present trend information to show if an individual class is improving or declining, nor does it track cumulative graduates from the courses.

3.4.1: Current Flight School XXI Process Metrics

FS XXI has made some progress according to the metrics it has been tracking. However, these metrics do not align well with the strategic goals of the enterprise, nor are they presented in a consolidated manner. Table 3-5 presents the combined data for all of the enterprise processes. Although the course adherence has been improving over the last few months, courses are still an average of 12 days behind schedule. Also, it appears that the enterprise is making progress on the number of flight hours behind schedule; however, they are still behind by over 1500 hours. The number of students in training is remaining almost constant because the enterprise is not cancelling courses when previous courses run over schedule. Additionally, the start deviation, number of days between planned and actual course start, has been decreasing, which is a positive trend.

	Course Adherence to Schedule (Average)	**Training Schedule Variance (Total)**	**Start Deviation (Maximum)**	**Number of Students (Total)**	**Annual Planned Load**
Report Date	**Days (+/-)**	**Hour (+/-)**	**Days (+/-)**	**Students**	**Students**
13-Apr-09	-46	-5854	0	1075	2400
27-Apr-09	-35	-4012	0	1085	2400
15-May-09	-19	-1503	71	992	2400
1-Jun-09	-25	-3171	71	1066	2400
15-Jun-09	-31	-2735	71	1040	2400
1-Jul-09	-13	-1213	71	1066	2400
15-Jul-09	-22	-2470	71	1033	2400
31-Jul-09	-28	-2850	0	1033	2400
17-Aug-09	-25	-3011	24	1062	2400
2-Sep-09	-26	-3234	24	1044	2400
14-Sep-09	-21	-3119	24	1061	2400
5-Oct-09	-12	-1546	9	1054	2400
Trend	**(-)**	**(-)**	**(-)**	**(=)**	**(=)**

Table 3-5: Current Flight School XXI Metric Values (110th Aviation Brigade 2009)

3.4.2: Bubble Trends

Figure 3-9 presents the overall bubble trend for FS XXI, which shows an overall increasing trend for the BOLC B (previously called BOLC IIIA) and IERW Phase 2 (Advanced Aircraft training). The data shows that the bubble for the IERW common course has been decreasing; however, this is misleading as the bubble moved upstream because of a slower BOLC B graduation rate. The total number of students not in training, the bubble, for the enterprise as a whole, has been rising.[2]

Figure 3-10 presents the bubble trend for the individual advanced aircraft. No substantial reduction in bubble size has occurred for any aircraft. Since the inputs to and

[2] BOLC IIIA in both the text and figures reflect the old course title, which historic data was based on.

production rates of each process are currently independent of downstream demand, the focus on a per-aircraft bubble is not very useful. Also, like the overall bubble data, some individual aircraft bubbles have been decreasing because the enterprise has assigned additional students to aircraft that have smaller bubbles in an effort to reduce the amount of time a student spends on Ft. Rucker. This may have the short term benefit of reducing wait times; however, as the decision is not made based on aviator demand, excess aviators for certain aircraft may affect the Combat Aviation Brigades. Appendix A contains the data for the student backlog from April 2008 to October 2009.

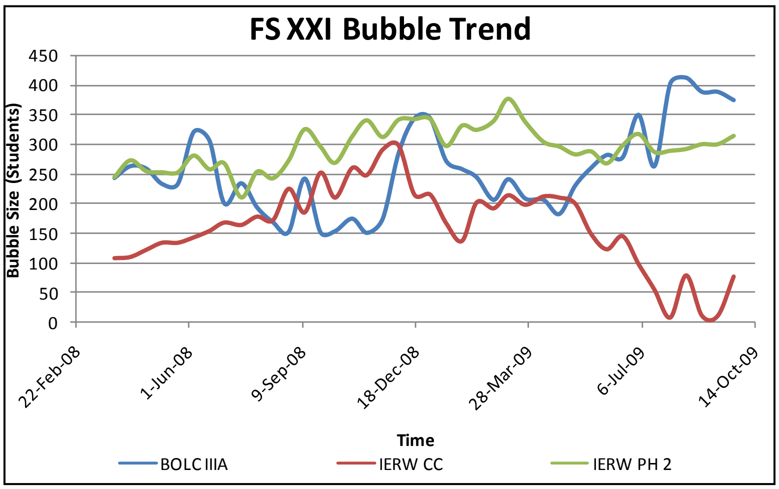

Figure 3-9: Flight School XXI Bubble Trend (1st Aviation Brigade 2009)

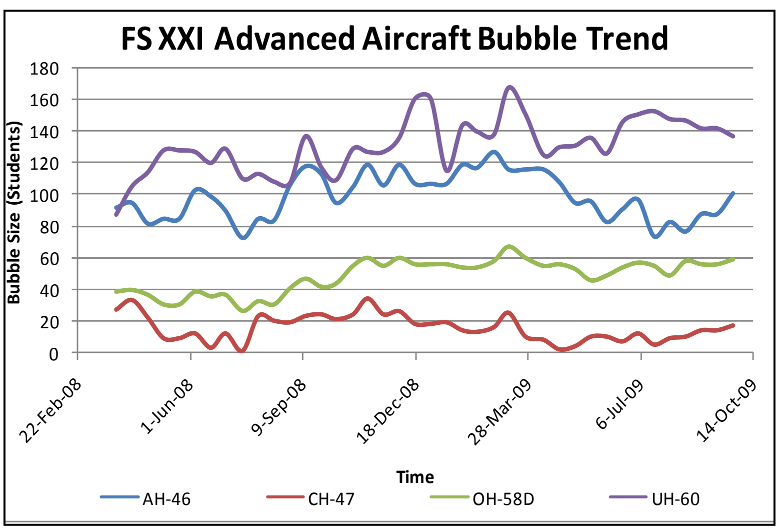

Figure 3-10: Advanced Aircraft Bubble Trend (1st Aviation Brigade 2009)

3.4.3: Weather Data

Table 3-6 presents the historic weather data for FS XXI and the number of days that weather affected flight training. Over the two years, the weekly average was 0.962 with a standard deviation of 0.929. In order to improve the regularity of graduation in their future state, it will be critical that FS XXI plan to deal with weather delays.

FY 2007				
Week	Start	End	Weather Days Per Week	Weather Days Per Month
1	01-Oct-06	07-Oct-06	0	
2	08-Oct-06	14-Oct-06	0	4
3	15-Oct-06	21-Oct-06	2	
4	22-Oct-06	28-Oct-06	2	
5	29-Oct-06	04-Nov-06	0	
6	05-Nov-06	11-Nov-06	1	
7	12-Nov-06	18-Nov-06	1	4
8	19-Nov-06	25-Nov-06	0	
9	26-Nov-06	02-Dec-06	2	
10	03-Dec-06	09-Dec-06	0	
11	10-Dec-06	16-Dec-06	1	1
12	17-Dec-06	23-Dec-06	0	
13	24-Dec-06	30-Dec-06	0	
14	31-Dec-06	06-Jan-07	3	
15	07-Jan-07	13-Jan-07	0	7
16	14-Jan-07	20-Jan-07	2	
17	21-Jan-07	27-Jan-07	2	
18	28-Jan-07	03-Feb-07	2	
19	04-Feb-07	10-Feb-07	1	5
20	11-Feb-07	17-Feb-07	1	
21	18-Feb-07	24-Feb-07	1	
22	25-Feb-07	03-Mar-07	1	
23	04-Mar-07	10-Mar-07	0	
24	11-Mar-07	17-Mar-07	3	4
25	18-Mar-07	24-Mar-07	0	
26	25-Mar-07	31-Mar-07	0	
27	01-Apr-07	07-Apr-07	1	
28	08-Apr-07	14-Apr-07	2	4
29	15-Apr-07	21-Apr-07	0	
30	22-Apr-07	28-Apr-07	1	
31	29-Apr-07	05-May-07	0	
32	06-May-07	12-May-07	2	
33	13-May-07	19-May-07	0	5
34	20-May-07	26-May-07	2	
35	27-May-07	02-Jun-07	1	
36	03-Jun-07	09-Jun-07	1	
37	10-Jun-07	16-Jun-07	0	3
38	17-Jun-07	23-Jun-07	2	
39	24-Jun-07	30-Jun-07	0	
40	01-Jul-07	07-Jul-07	2	
41	08-Jul-07	14-Jul-07	1	5
42	15-Jul-07	21-Jul-07	2	
43	22-Jul-07	28-Jul-07	0	
44	29-Jul-07	04-Aug-07	0	
45	05-Aug-07	11-Aug-07	0	
46	12-Aug-07	18-Aug-07	1	4
47	19-Aug-07	25-Aug-07	1	
48	26-Aug-07	01-Sep-07	2	
49	02-Sep-07	08-Sep-07	0	
50	09-Sep-07	15-Sep-07	3	5
51	16-Sep-07	22-Sep-07	2	
52	23-Sep-07	29-Sep-07	0	

FY 2008				
Week	Start	End	Weather Days Per Week	Weather Days Per Month
1	30-Sep-07	06-Oct-07	1	
2	07-Oct-07	13-Oct-07	0	
3	14-Oct-07	20-Oct-07	2	4
4	21-Oct-07	27-Oct-07	1	
5	28-Oct-07	03-Nov-07	0	
6	04-Nov-07	10-Nov-07	0	
7	11-Nov-07	17-Nov-07	0	2
8	18-Nov-07	24-Nov-07	1	
9	25-Nov-07	01-Dec-07	1	
10	02-Dec-07	08-Dec-07	2	
11	09-Dec-07	15-Dec-07	3	5
12	16-Dec-07	22-Dec-07	0	
13	23-Dec-07	29-Dec-07	0	
14	30-Dec-07	05-Jan-08	0	
15	06-Jan-08	12-Jan-08	2	
16	13-Jan-08	19-Jan-08	2	7
17	20-Jan-08	26-Jan-08	2	
18	27-Jan-08	02-Feb-08	1	
19	03-Feb-08	09-Feb-08	1	
20	10-Feb-08	16-Feb-08	2	6
21	17-Feb-08	23-Feb-08	2	
22	24-Feb-08	01-Mar-08	1	
23	02-Mar-08	08-Mar-08	2	
24	09-Mar-08	15-Mar-08	1	4
25	16-Mar-08	22-Mar-08	1	
26	23-Mar-08	29-Mar-08	0	
27	30-Mar-08	05-Apr-08	2	
28	06-Apr-08	12-Apr-08	0	2
29	13-Apr-08	19-Apr-08	0	
30	20-Apr-08	26-Apr-08	0	
31	27-Apr-08	03-May-08	1	
32	04-May-08	10-May-08	0	
33	11-May-08	17-May-08	2	3
34	18-May-08	24-May-08	0	
35	25-May-08	31-May-08	0	
36	01-Jun-08	07-Jun-08	0	
37	08-Jun-08	14-Jun-08	2	
38	15-Jun-08	21-Jun-08	0	5
39	22-Jun-08	28-Jun-08	2	
40	29-Jun-08	05-Jul-08	1	
41	06-Jul-08	12-Jul-08	1	
42	13-Jul-08	19-Jul-08	0	2
43	20-Jul-08	26-Jul-08	0	
44	27-Jul-08	02-Aug-08	1	
45	03-Aug-08	09-Aug-08	1	
46	10-Aug-08	16-Aug-08	3	7
47	17-Aug-08	23-Aug-08	1	
48	24-Aug-08	30-Aug-08	2	
49	31-Aug-08	06-Sep-08	0	
50	07-Sep-08	13-Sep-08	0	2
51	14-Sep-08	20-Sep-08	2	
52	21-Sep-08	27-Sep-08	0	

Table 3-6: Weather Data for FY 2007 and 2008 (ACLC 2009)

3.4.4: Current Trend Analysis

The current trends of the FS XXI metrics are not very encouraging. Although some metrics appear to be improving, "course adherence to schedule" and "training schedule variance", it is difficult to determine if these improvements are real or just part of a cyclical trend. It will be important to continue to track these metrics to determine if USAACE achieved long-term improvements to the system and the causes of these improvements. Figure 3-11 depicts how these metrics appear to be decreasing; however, in the past the metrics appear to oscillate.

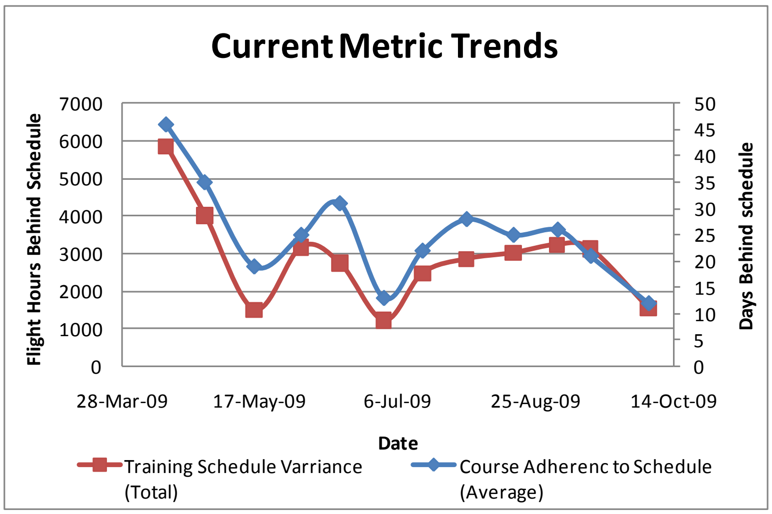

Figure 3-11: Current Metric Trends (110th Aviation Brigade 2009)

Also, the bubble trends are not very positive as the overall trend is an increase in the number of students not in training. If the bubbles are increasing with an inflow of 1200 students annually, they will increase drastically when HRC begins sending 1498 students in FY 2012. So, the USAACE has a window of about 18 months to ensure that the process performance metrics are indeed improving and reverse the trend of a growing bubble of students not in training.

3.5: Enterprise Interactions

Figure 3-12 presents a map of the information, material, and resource interactions for the enterprise. A majority of the interactions that occur in the enterprise are information interactions between the different groups. Table 3-7 presents information regarding the individual interactions based on interviews conducted with the different stakeholder groups within the USAACE. Interactions are rated green, indicating that they do not need improvement; yellow, need some improvement; or red, a great deal of improvement. Improved interaction in the identified areas is critical to eliminating waste from the enterprise.

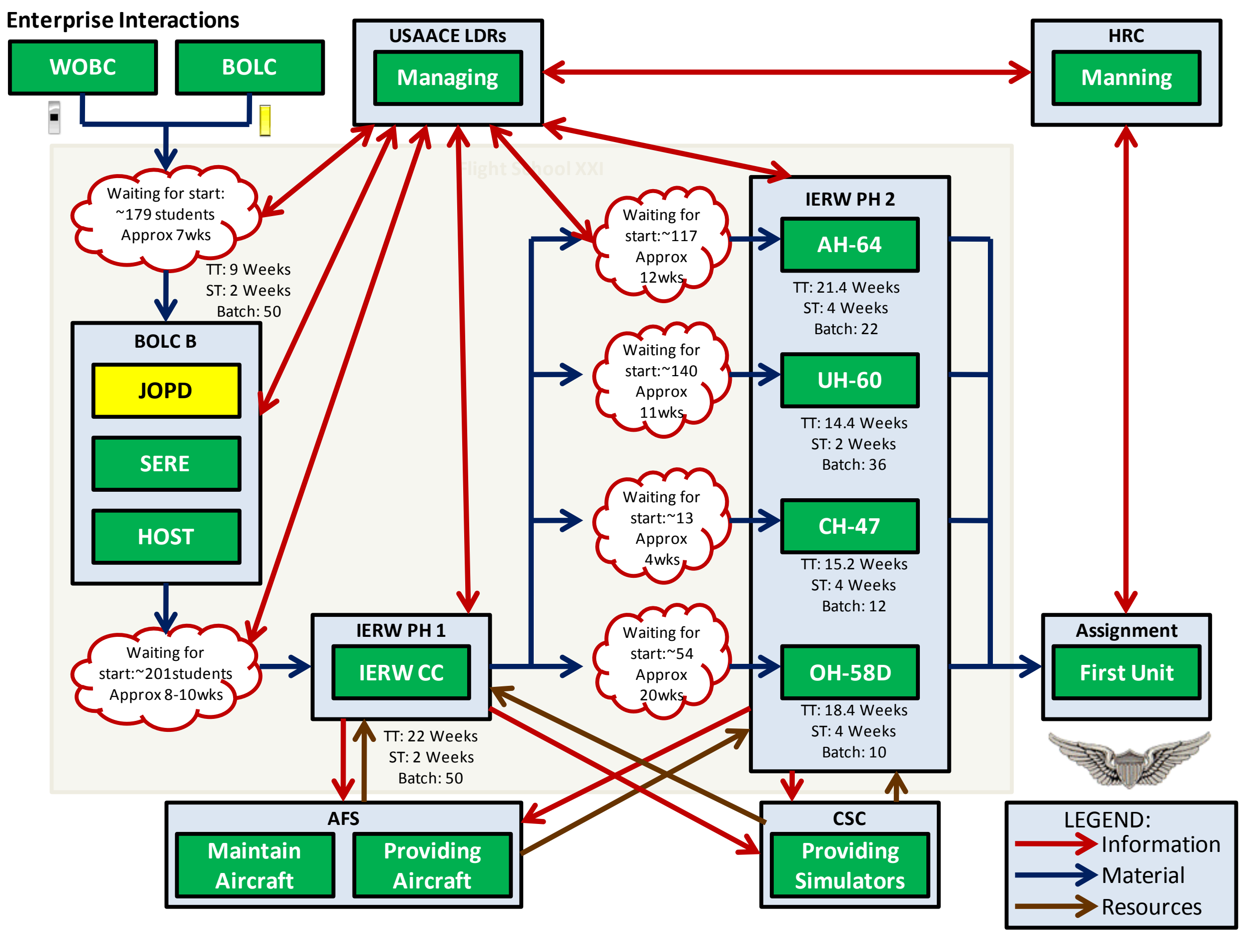

Figure 3-12: Enterprise Level Interactions

It is important to note that the USAACE currently recognizes the need to improve these interactions and has recently established a contract to provide an enterprise scheduling system, the Graduate Training Integration Management System (GTIMS). This new system will enable Instructor Pilots to take a more active role in scheduling aircraft to ensure that they receive the resources they require for training and will provide USAACE leadership with more visibility into how the enterprise is utilizing their resources. However, there is one concern with implementing this system. The current interaction between the IPs for the Advanced Aircraft and the CSC utilizes a similar system, but is not an efficient interaction. (See Table 3-7) So, as the USAACE implements GTIMS they must conduct proper training and enforce the proper utilization of the system for it to be effective.

Cross-Org	Dot	Interaction goes:		Type			Proactive	Reactive	Stability	Timeliness	Accuracy	Completeness	Note
		From	To	Info	Material	Resources							
		FS XXI Team	LDRSHP	X			X		L	H	H	H	
		FS XXI Team	110 AB	X			X		L	H	H	H	
		AFS	FS XXI Team	X				X	M	M	M	M	
		FS XXI Team	AFS	X			X		H	H	H	H	
		FS XXI Team	CSC	X			X		L	H	H	H	
		IPS (C.C.)	CSC	X			X		H	H	H	H	Great use of IT w/ online scheduling process
		IPS (Adv. Aircraft)	CSC	X			X		M	M	H	H	
		CSC	IPS			X		X	H	H	H	H	
		LDRSHP	AFS	X			X		H	H	H	H	
		LDRSHP	CSC	X			X		H	H	H	H	
		LDRSHP	HRC	X			X		H	M	M	H	
		LDRSHP	110/1 AB	X			X		H	H	H	H	
		110/1 AB	LDRSHP	X			X		H	H	H	H	
		110 AB	1 AB	X				X	H	H	M	M	Aircraft Selection
		1 AB	101 AB		X		X		M	H	M	M	
		IPS	LDRSHP	X				X	M	H	M	M	
		110 AB	Students	X				X	H	M	H	M	Transfer across organization, changes not confirmed
		IPS	AFS	X			X		H	H	L	H	Aircraft configuration for individual IP req.
		AFS	IPS			X	X		H	H	M	H	Based on scheduler's input to system

Table 3-7: Enterprise Level Interaction Evaluation (Leadership 2009)

- **FS XXI Team – Leadership:** In this interaction the members of the FS XXI Team and the leadership of the USAACE exchange information on a proactive basis. This is good as information flows between the team responsible for making recommendations for integrating flight training and the leadership of the USAACE. However, they rated this interaction as low because of the instability and infrequency of the interaction.
- **FS XXI Team – 110th AB:** Similar to the previous interaction, they rated this interaction as yellow because the interaction does not occur on a regular basis. However, it is a proactive information exchange and appears to be a good interaction despite the lack of stability.
- **AFS – FS XXI Team:** Again, they rated this interaction as yellow because of low stability and the fact that this interaction is more reactive in nature. In this interaction, information flows from AFS, the maintainers, to the FS XXI Team, responsible for flight training

integration; however, it usually only occurs when there have been problems with the maintenance or delivery of aircraft.

- **FS XXI Team – AFS:** This interaction is the flow of information from the FS XXI Team to the maintainers at AFS. They rated this interaction as green because information flows on a more consistent basis and is a proactive relationship. In this interaction, the FS XXI Team provides information regarding flight training to AFS.
- **FS XXI Team – CSC:** This interaction is the flow of information from the FS XXI Team to the resource providers at the simulation center. They rated this interaction as yellow, only because of the lack of stability in the interaction. The interaction is very good, other than the infrequency of interactions.
- **IPs (Common Course) – CSC:** Based on the feedback from the CSC management, the interactions with the IPs fall into two categories: first, the IPs for the IERW Common Core and second, into the IPs for the advanced aircraft as there is a variation in the interactions. This interaction is a digital exchange of information as Instructor Pilots can access the scheduling system and request a simulator up to 24 hours in advance for their students. Each instructor pilot is able to access the system, so it is very stable, accurate, and timely and overall is a very efficient interaction.
- **IPs (Advanced Aircraft) – CSC:** Although the system is the same for both the common course and the advance aircraft instructor pilots to request resources from CSC, this interaction is not as efficient between the advanced aircraft IPs and CSC. This interaction is less timely and stable than the interaction with the Common Core IPs and the enterprise loses some of the efficiencies gained with the digital scheduling system.
- **CSC – IPs:** In this interaction, CSC provides the instructor pilots with the simulator resources necessary for training. They rated this interaction as yellow because it is reactive in nature. Also, CSC reliably provides simulators, when they are properly scheduled; however, if the instructor pilots do not schedule the simulators, as noted in the previous interactions, there is a chance the simulators could be undergoing maintenance when needed for training. CSC provides simulators as requested to the instructor pilots and only when requested through their scheduling software. Although IPs can utilize the scheduling software to view

simulator status and availability, they rarely take advantage of available simulators to conduct additional training or substitute training on weather days.

- **USAACE Leadership – AFS / CSC:** These two interactions combine into one description because they share similar attributes despite being between different agencies. In these interactions, information flows both ways from the leadership to AFS and CSC in a proactive manner to address concerns and report information on the enterprise. They rated both interactions as green because they are stable, accurate, timely, and generally complete.
- **USAACE Leadership – HRC:** This interaction occurs outside of the enterprise that the USAACE Leadership rated as yellow because it is not very timely as the requirements for aviators change faster than USAACE can adapt to minor changes in requirements. The information that flows in this interaction is the requirements for aviators in the combat aviation brigades.
- **USAACE Leadership – 110th / 1AB:** This interaction represents the two-way flow of information between the leadership and the aviation brigades. As one would expect in a hierarchical, military organization, the information flow between the subordinate unit, aviation brigades, and the higher headquarters is very good. This interaction is timely, accurate, stable, and complete. The majority of the information exchanged is on the status of training, consolidated into a daily "Status of Flight Line" report. Additionally, there is a bi-weekly report of the student training status provided by the 1st Aviation Brigade which is responsible for all students in flight training.
- **110th AB – 1st AB:** The two brigades share information in this interaction and rated it as yellow because the interaction is not very timely or accurate. First, there are difficulties in providing updated training schedules from 110 AB, who writes the training plan, and the 1 AB who controls the students who are required to attend this training. Also, there are problems with information with aircraft selection as 110 AB does not receive a timely report on the status of the aircraft selected by students to determine future requirements.
- **IPs – USAACE Leadership:** This interaction involves the flow of information to and from the Leadership to the Instructor Pilots. They rated this interaction as yellow because this

interaction is generally reactive in nature and flows through multiple levels of the hierarchal organization of the USAACE.

- **110th AB – Students:** This interaction involves the flow of information from the 110th AB who plan and execute the training to the students who participate in the training. During the conduct of classes, when the students interact with 110th AB on a daily basis, this information flow is relatively good because the students get information directly from their instructor pilot. However, in the time between courses and when the students are not interacting with the instructor pilots, this interaction is not as good because the information has to flow from 110 AB to the USAACE Leadership to 1 AB and finally down to the students.
- **IPs – AFS:** They rated this interaction as red because of the low accuracy of the information transferred between the instructor pilots and AFS. This includes requests for aircraft and the specific requirements for the configuration of an aircraft based on specific training events that are to occur that day. However, a breakdown of information flow occurs between the instructor pilot's requirements and the information that AFS receives. Currently, the training unit's head scheduler transmits this information which creates waste in the process. The USAACE has recognized this problem and is deploying the enterprise scheduling software (GTIMS) to improve this interaction.
- **AFS – IPs:** In this interaction, AFS delivers the resources to the instructor pilots based on the previous interaction. They rated this interaction as yellow because it relies on the accurate flow of information from the IPs and AFS. AFS does a relatively good job delivering the resources that the unit scheduler requests; however, if this information does not match the instructor pilots' needs, then the physical interaction with the resources is also poor.

3.6: Enterprise Alignment: X-Matrix

Interviews with USAACE staff and data collected from the stakeholders provided information for the X-Matrix that maps the 16 stakeholder values, 12 strategic objectives, 11 metrics, and 11 enterprise processes. The matrix presents the interactions between the objectives and metrics, metrics and processes, processes and values, and values and objectives as strongly aligned (blue), somewhat aligned (yellow), or not aligned (white). Figure 3-13 presents the current state X-Matrix for FS XXI.

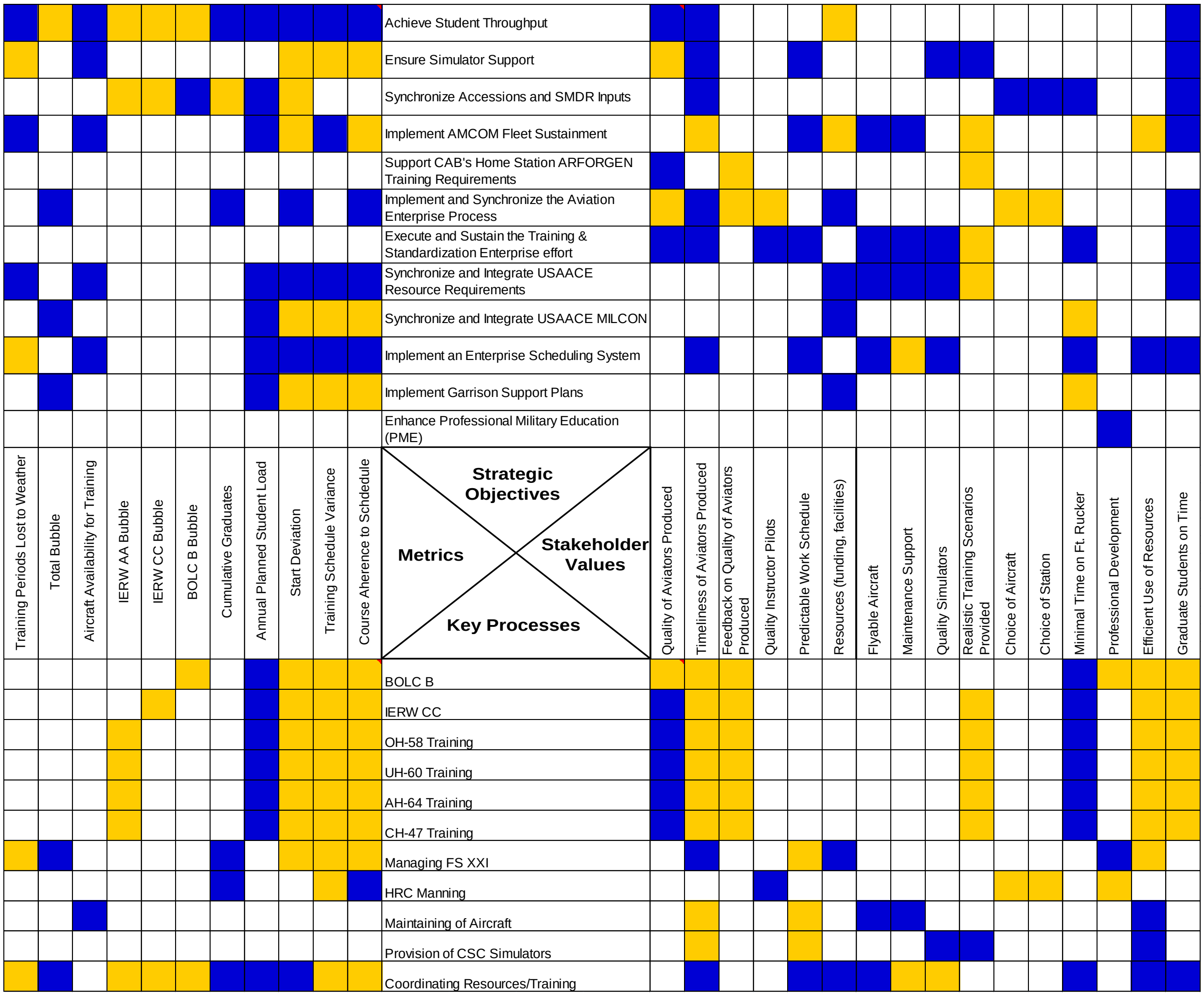

Figure 3-13: Current Enterprise X-Matrix (Enos, et al. 2009)

3.6.1: Alignment of Strategic Objectives to Stakeholder Values

The USAACE recently updated its strategic objectives to better reflect the enterprise stakeholders' values. These strategic objectives align well with a majority of the stakeholder values and support the enterprise's stakeholders. This is evident as all stakeholder values at least weakly align with a strategic objective. However, a few stakeholder values only have weak alignment to strategic objectives.

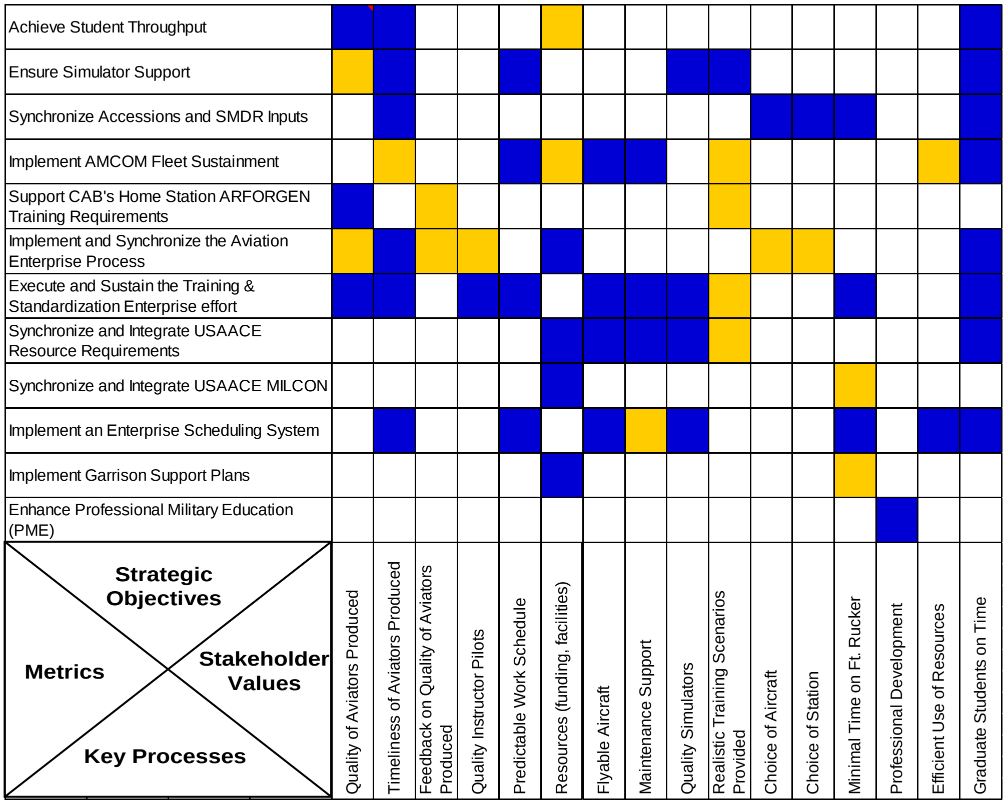

Figure 3-14: X-Matrix – Strategic Objectives vs. Stakeholder Values

The CAB Battalion Commanders' value of providing feedback on the quality of aviator produced does not strongly align with any strategic objective. This illustrates the fact that the enterprise does not have a method to solicit feedback on the quality of aviators produced from the customer. There is no strategic objective to ensure that the enterprise interacts with CAB Battalion Commanders. This continues throughout the X-Matrix as there are no metrics to measure quality or processes to solicit feedback from the customer.

3.6.2: Alignment of Metrics to Strategic Objectives

The metrics used by the USAACE to measure FS XXI do not align well with the enterprise's strategic objectives. There are two specific conclusions to make from this portion of the X-Matrix. First, three objectives do not have metrics and are currently not measured by the enterprise. Second, the metrics that gets the most attention, the various bubbles, only weakly aligns with strategic objectives. To simplify the X-Matrix, I consolidated the different advanced aircraft bubble metrics into one metric, as these metrics had the same alignment with strategic objectives and processes.

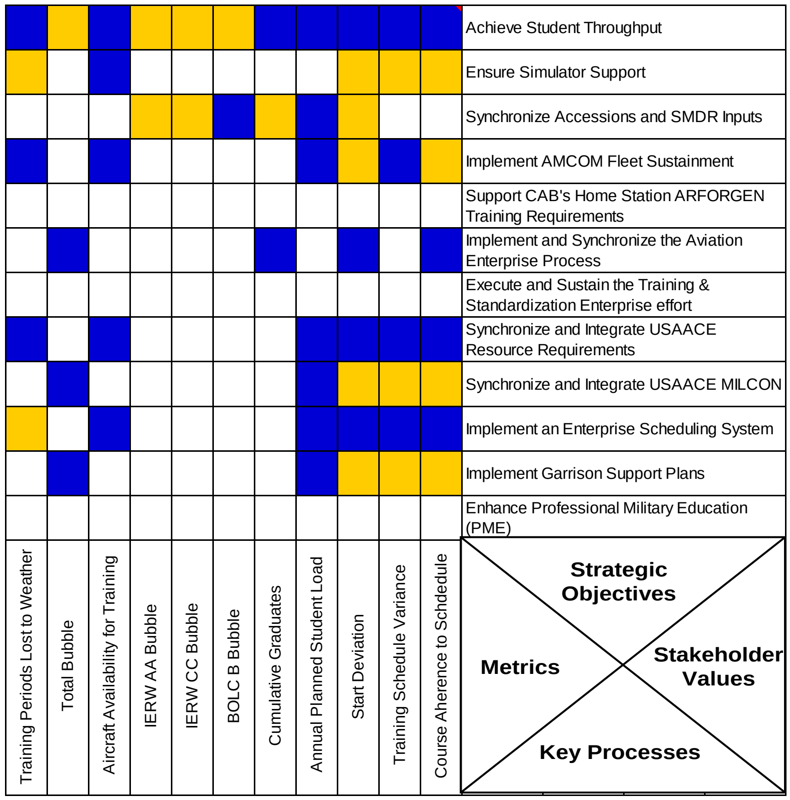

Figure 3-15: X-Matrix – Metrics vs. Strategic Objectives

Currently, three strategic objectives do not have associated metrics to measure their performance. There are no metrics to measure the objectives: Enhance the Professional Military Education (PME), Execute and Sustain the Training and Standardization Enterprise Effort, and Support the CAB’s Home Station ARFORGEN Training Requirements. This creates and opportunity for the USAACE to develop measurable metrics they can use to drive decisions in support of these strategic objectives.

The metrics that receive the most attention for the USAACE leadership as well as Army leadership are the various bubble measurements. The predominant mental model is that reducing the bubble will improve the performance of FS XXI. However, as the X-Matrix shows, these metrics are only weakly align with strategic objectives. If the Army decided to transfer all students in the bubble to a different branch, this metric would show that FS XXI’s performance increased. However, the USAACE did not improve any processes or balance the flow of students, so nothing really changed. These metrics are important to maintain accountability of the students; however, they do not align well with the strategic objectives and should not be the focus of the USAACE leadership. The USAACE should develop a more appropriate metric to measure the performance of the FS XXI processes that aligns with the strategic objectives.

3.6.3: Alignment of Metrics to Processes

The main processes of the FS XXI Enterprise are the training courses, BOLC B, IERW Common Course, and the Advanced Aircraft Courses. Several metrics measure these processes; however, these metrics focus on the start of the course and not the output of the course. Also, the bubble metrics weakly align with these processes because they measure the number of students awaiting these courses, but do not necessarily measure the processes. Also, these metrics do not appear to be associated with decisions to modify the processes to improve performance.

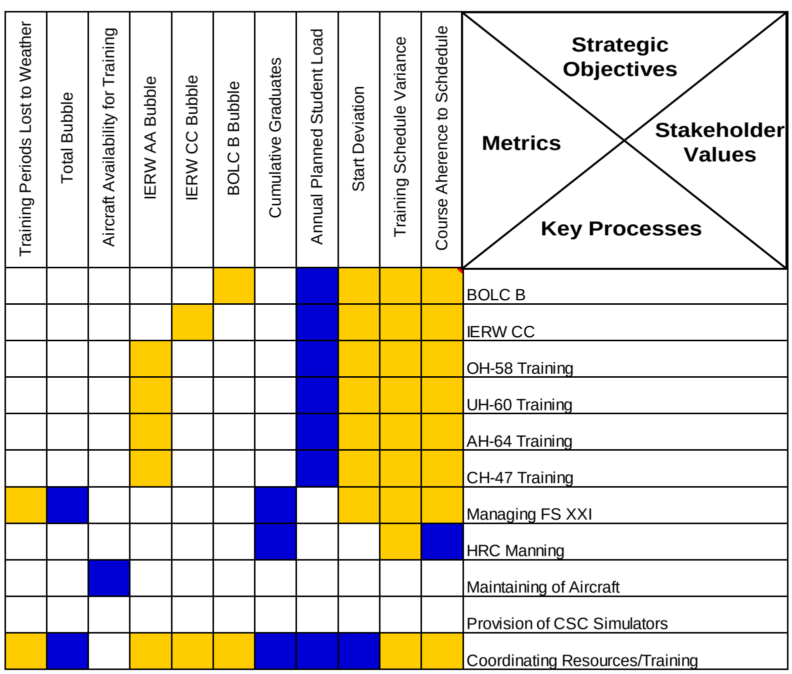

Figure 3-16: X-Matrix – Key Processes vs. Metrics

Additionally, the enterprise does not have very good metrics to measure the supporting processes necessary for operation of the enterprise. At the enterprise level, there are no metrics to measure the process of providing simulators. The CSC maintains internal metrics for performance, but it does not appear that the enterprise uses these metrics to make decisions for training. This is similar for the availability of aircraft metric which AFS maintains, but the enterprise tracks this metric more closely because flight hours are a bottleneck in the training process. However, this metric only tracks how well AFS does in providing fully-mission capable aircraft and not if an instructor pilot uses the aircraft for training a student.

As different organizations capture individual metrics, the enterprise is unable to correlate the metrics to determine the root cause behind problems. One organization collects data on the metrics regarding "training schedule variation" and "course adherence to schedule" and another organization tracks the "training periods lost to weather" and "aircraft available for training" metrics. This makes it extremely difficult to determine why the process deviated from the schedule. Obviously, a training period lost because of weather will delay the course, but there could be other reasons that could emerge with better metrics.

3.6.4: Alignment of Processes to Stakeholder Values

All of the key enterprise processes strongly align with stakeholder values, which indicate that the processes should be delivering value to the stakeholders. Also, most of the stakeholder values have at least one process that strongly correlates and all of them have weak correlations. Two stakeholder values that weakly align with a process are the student's values of choice of aircraft and duty station. It is unlikely that the enterprise will expend any resources to improve this alignment because the needs of the Army dictate what types of aviators they need and what duty stations are available.

The one value which the enterprise could improve upon is the feedback on the quality of aviators produced. Currently, the enterprise does not have a process for CAB Battalion Commanders to provide feedback to the USAACE on the performance of new aviators. This feedback mechanism could provide the USAACE leadership with valuable information on the performance of Flight School XXI as well as any impacts that potential changes to the enterprise may have.

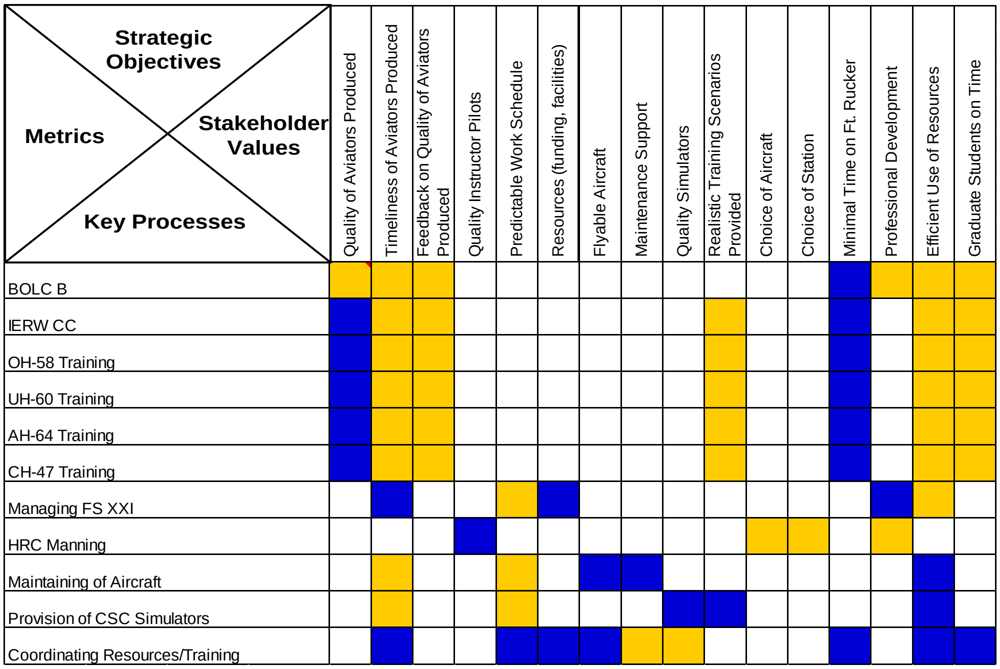

Figure 3-17: X-Matrix – Stakeholder Values vs. Key Processes

3.7: Enterprise Level Waste

Womack and Jones defined waste as "any human activity which absorbs resources but creates no value" (1996). The FS XXI Enterprise generates waste in several different areas, which they could eliminate to create more value for stakeholders. Enterprises generate waste in the following categories: waiting/delays, excessive transportation, inappropriate processing, inventory, excessive motion, defects/rework, over production, structural inefficiencies, and opportunity costs (Nightingale, Stanke and Bryan 2008). The FS XXI Enterprise creates waste in several of these categories which impede the enterprise's performance.

Waiting/Delays: There are inherent delays and waiting in the current enterprise value stream as the enterprise has not aligned the output of the different courses to ensure that there is continuous flow through the system. Two week delays occur between the end of the IERW Common Course, which ends every two weeks, and the beginning of the AH-64, CH-47 and OH-58D advanced aircraft courses, which start every four weeks. Although this delay does not affect the number of aviators produced, it does create waste as students for these aircraft wait two weeks for training to begin.

Inappropriate Processing: This type of waste is evident in the enterprise metrics, as the enterprise currently tracks metrics that are not effective. The enterprise expends a large amount of effort maintaining metrics that do not accurately measure the enterprise processes or drive decisions. Also, the enterprise doe not consolidate or present these metrics in a comprehensible manner for decision makers to analyze. As these metrics do not affect decisions, they currently do not add any value to the stakeholders and only measure the failure of the enterprise's processes.

Inventory: This is the largest type of waste generated by the FS XXI Enterprise and is evident in the large bubbles of students awaiting training. In addition to the waste created by excess inventory, there are second and third order effects which create even more waste for the enterprise. The immediate effect of the excess inventory is increased wait time between classes as there are hundreds of students awaiting training. At the current level of students not in training, the enterprise could operate for approximately six months without receiving a new lieutenant or warrant officer.

Defects/Rework: This type of waste occurs in two areas of the enterprise. First, there are defects in the current aircraft scheduling process. Under the current process, information does not flow from the instructor pilots to the maintainers in an effective or accurate manner. The aircraft that are scheduled and provided by the maintainers are not necessarily the aircraft that the instructor pilots need for that day's training. This creates waste as instructor pilots and maintainers have to correct the defects in the schedule at the flight line, decreases the amount of time they have to train their students. The other area that rework emerges is a second order effect of the excess inventory of students not in training. The wait in the bubble between the common course and the advanced aircraft courses quickly degrade the students' aviator skills and instructor pilots spend valuable time re-teaching basic aviator skills.

Over Production: Over production is currently occurring because of the inventory of students not in training. The processes at the beginning of the FS XXI value stream are producing more aviators than the system can currently handle because backlog of students before the advanced aircraft courses. Also, in an effort to reduce the bubble, the enterprise has over produced some types of aviators because they send additional pilots into advanced aircraft courses with the shortest wait time. Although this appears to be eliminating the problem of excess inventory, the Army does not need these extra aviators in certain aircraft and this is not delivering value to the customers.

Opportunity Costs: The opportunity cost associated with inefficient processes is the $35 million spent to pay aviators in the bubble. During their time awaiting training, they are not providing value for the Army which is creating a huge amount of waste. There are additional intangible opportunity costs as these young aviators are missing opportunities to lead soldiers in a Combat Aviation Brigade before the Army promotes them to the next rank. Officers only spend about 30 to 36 months as a lieutenant before the Army promotes them to captain and if 24 months is spent in FS XXI, they only have a limited amount of time to spend in key developmental positions.

3.8: Opportunities for Improvement

There are several opportunities for improvement of the FS XXI Enterprise. First, the elimination of the identified enterprise waste will be essential to improving the performance of the enterprise and the value deliver to stakeholders. Second, there is an opportunity to improve the metrics and processes to better align with the enterprise's strategic objectives. Also, there are opportunities to improve the interactions between the various organizations and stakeholders that make up the FS XXI Enterprise. Finally, there is an opportunity to improve the individual processes of training aviators with the data collected during this analysis which could reduce the schedule variation.

So, after conducting an analysis of the current state of the enterprise, there case for change is strong and there are several opportunities for improvement. Also, the enterprise leadership has expressed a strong interest in changing and willingness to eliminate years of inefficient processes to become a better enterprise.

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Chapter 4: Process View of the Enterprise

This chapter presents an examination of the AH-64 Advanced Aircraft course portion of the Flight School XXI (FS XXI) Enterprise through the process view of Enterprise Architecture. The process view is the "core leadership, lifecycle and enabling processes by which the enterprise creates value for its stakeholders" (Nightingale 2009). However, the Enterprise Architecture framework shows that the process view is not independent of the other views of the enterprise and the strategy, organization, knowledge, and product views influence the processes. Additionally, the FS XXI Enterprise demonstrates a link between the Policy/External Influences and Process Views which the current Enterprise Architecture framework currently does not recognize. The complexity of the AH-64 process and the interactions with the other views provides an opportunity to utilize System Dynamics as a tool for better understanding the process and modeling potential course of action to improve the system.

4.1: System Dynamics

System Dynamics is an approach to understand the dynamic complexity that exists within systems, simulate the behavior of systems over time, adjust individuals' mental models of the system, and implement policies to improve the system. Forrester described the potential for system dynamics as an approach that should help in the important high-level management problems (1961). He noted that solutions to small problems will only yield small results and that people get mediocre results by setting improvement goals too low. He suggests that the change must be at the enterprise level to achieve major improvement and that the goal should be to determine policies that lead to greater success (Forrester 1961). In his book World Dynamics, he developed a model of the world to understand the dynamic complexity and limits to growth of the world and the interrelations between population, capital investment, geographical space, natural resources, pollution, and food production (Forrester 1971).

To better understand the approach of System Dynamics, one should examine the terms "system" and "dynamics" as utilized by the literature on System Dynamics. Forrester describes a system as "a grouping of parts that operate together for a common purpose" (1968). He further classifies two types of systems: open systems, in which exogenous, or external, variables affect the system, or closed systems, in which all variables are endogenous, or internal to the system (Forrester 1961). The distinction between open and closed systems relies heavily on where the system boundary is drawn; however, a model of a system will provide a better understanding of the dynamics the closer it is to a closed system. Dynamics are the behavior of a system over time, which are generally complex and non-linear in nature (Forrester 1961). System Dynamics attempts to understand the dynamic complexity that is inherent in any natural or human system. Even the simplest of systems, with apparently low levels of structural complexity, can exhibit high levels of dynamic complexity. This complexity comes from feedback within the system, time delays between decisions and effects, and the learning process of the system (Sterman 2000).

Applications of System Dynamics have provided insights into the dynamics of several different areas including corporate policy, the dynamics of infectious disease and diabetes, drug addiction in a community, and the dynamics of commodity markets (Forrester 1971). Companies and consultants have extensively used System Dynamics for managing large, complex projects with a great deal of success. One area where they utilize system dynamics models is in evaluating process changes to ongoing projects. These changes usually incur short term costs to the enterprise; however, the enterprise often does not realize the benefits of these changes until much later. Thus, the enterprise abandons these changes before they reap the potential benefits because they fail to understand the dynamics of the change (Lyneis, Cooper and Els 2001). Additionally, System Dynamics can identify the underlying reasons behind project scope and budget overruns. Lyneis and Ford describe two types of feedback effects that impact project performance. First, ripple effects come from actions managers take to correct poor project performance that create second or third order effects. For example, a project manager may hire additional people to improve productivity; however, the time required to train new employees actual detracts from productivity. The other effects they describe are knock-on effects which generate destructive dynamics by amplifying the effects of the ripple effects. For example, the errors create more work effect creates more work because these errors must be corrected and downstream work might have to be re-done due to errors in previous tasks (Lyneis and Ford 2007). Although the process of training students does not meet the definition of a project, the dynamics Lyneis and Ford described are evident in the FS XXI Enterprise.

Another area in which businesses utilize System Dynamics is in the development of their corporate strategy and analysis of business decisions. Generally, a crisis or complex problem triggers these shifts in business strategy and System Dynamics can provide insights into how the problem arose and help to determine the root cause of the crisis. Additionally, System Dynamics can assist in determining the consequences of alternative courses of action the business could take and the impact of the leadership's decisions.

Lyneis presents a four phase framework for working with clients to solve these complex problems using System Dynamics (1999).

1. Business Structure Analysis: The consultant utilizes systems thinking tool such as behavior over time graphs and causal loop diagrams to clearly identify the problem.
2. Development of a Small, Insight-Based Model: The consultant develops a general system dynamics model of the business which identifies the underlying dynamics.
3. Development of a Detailed, Calibrated Model: The modeler develops and calibrates a detailed model that assures the model contains the proper structure to exhibit the problem behavior, accurately determine the cost-benefit of alternatives, and facilitates the development of strategy.
4. Continuation of the Relationship: The client and the modeler learn from the behavior of the business and update the model to better understand the dynamics (Lyneis 1999).

This framework provides a guide for evaluating the problem faced by the FS XXI Enterprise utilizing System Dynamics. The application portion of this chapter generally follows the first three phases of Lyneis's framework to determine the underlying dynamics of the AH-64 Advanced Aircraft, development of a model to simulate observed behavior, and evaluate alternative courses of action to correct the problems identified.

4.1.2: Causal Loops

Causal loops are one of the key elements of the system dynamics approach and are closed loop processes. System Dynamics uses signed diagrams to represent these loops and designates them as reinforcing or balancing loops. Casual loops are different from discrete, event-oriented perspective of individual causes and effects in that they acknowledge that in a closed system any cause is an effect and any effect is a cause (Richardson 1991). In System Dynamics, the feedback loop diagrams indicate that one variable influences another through physical or information flows. One is able to describe the behavior of the system by talking through the loop to tell the story of the interactions within the system (Meadows, Randers and Meadows 2004).

Richardson describes a positive, also known as a reinforcing feedback loop as a chain of cause and effect relationships that amplify a change in any one of the elements (1991). They operate so that a change to any element in the loop in one direction will flow through the loop and finally change the original element in the same direction. So, if one element is increased, the consequences of that change will travel through the loop and further increase the original element. However, the title of positive loop does not necessarily mean that that the loop will have favorable results, to combat this notion some refer to these loops as reinforcing loops. An additional aspect of these loops is that whenever a stock exists in a positive feedback loop it has the potential to grow exponentially (Meadows, Randers and Meadows 2004).

The other type of feedback loop is the negative or balancing feedback loop, which works to diminish the effect of a change in a system (Richardson 1991). In System Dynamics, a negative feedback loop generally exists to bring a system back to a desired level or a level constrained by the system. Forrester describes a first-order negative feedback loop using the example of a simple inventory control system. When the actual inventory falls below the desired inventory, the order rate increases, which in-turn increases the inventory (Forrester 1968). So, as one element is decreased the consequences of this decrease travel through the loop to increase the original element.

However, in natural or human systems there are often delays in information or material which increase the dynamic complexity of these systems. Forrester specifies material delays as delays in which no units will be lost during the delay, but the delay will cause the inflow to differ from the outflow, which will create an accumulation of the material. On the other hand, the value of information that a system delays may diminish over time as people make decisions based on old or inaccurate information (Forrester 1961). These delays can have dramatic effects on a system's behavior over time. Delays can cause a system to overshoot is limits when the feedback signal is delayed which prevents the system from establishing an orderly balance within its limits. Additionally, the delay can cause a system to overshoot its natural limit and collapse when the delay in the feedback signal allows the system to continue to grow past is limit to a point where it causes irreversible damage to the system's limits (Meadows, Randers and Meadows 2004).

One of the simplest examples of a causal loop diagram is the chicken and the egg example to demonstrate reinforcing and balancing feedback loops. Figure 4-1 presents the chicken and egg reinforcing feedback loop and Figure 4-2 presents the chicken and road crossing balancing feedback loop (Sterman 2000).

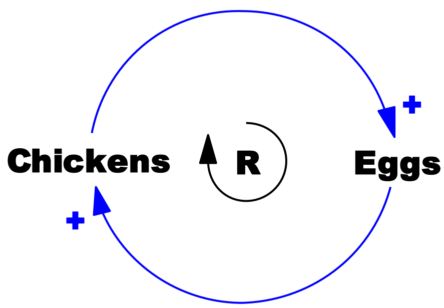

Figure 4-1: Reinforcing Feedback Loop[3]

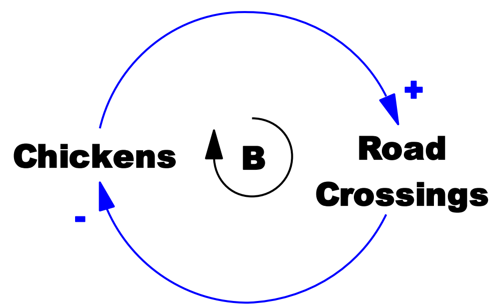

Figure 4-2: Balancing Feedback Loop[3]

In the reinforcing feedback loop, if the number of chickens increases, this causes the number of eggs to increase. In turn, the increase in eggs causes an increase in chickens. This demonstrates how a reinforcing feedback loop could generate exponential growth. If every chicken laid two eggs, then each time around the feedback loop the number of chickens would double, thus creating exponential growth. The balancing feedback loop self-corrects the system to some equilibrium point, in the chicken and road crossing example, the equilibrium is zero. If the number of chickens increases, this causes the number of road crossings to also increase. However, an increase in road crossings leads to a decrease in chickens. As drawn, this loop will continue to run until there are no chickens left to cross the road. These are simple examples of reinforcing and balancing feedback loops that create linear behavior for a system. The true dynamics of a system emerge as feedback loops interact to generate behavior.

[3] Figure 4-1 and Figure 4-2 adapted from Sterman 2000.

4.1.3: Stocks and Flows

The other major components of system dynamics models are stocks and flows. A stock is a measurable accumulation of material or information in a system. Where as a flow is an instantaneous rate of change of material or information between stocks in a model (Forrester 1961). Mathematically, the value of the stock is equal to the integral of the combined inflows and outflows into and out of the stock.

Again, a simple example of a stock and flow graph for a well known system best describes this concept. Figure 4-3 presents a diagram of a bath tub, a simple system that consists of an inflow, the faucet; an outflow, the drain; and a stock, the tub. In this case, if the inflow from the faucet exceeds the outflow of the drain the tub will fill with water. If the outflow exceeds the inflow, then the bath tub will begin to empty (Sterman 2000).

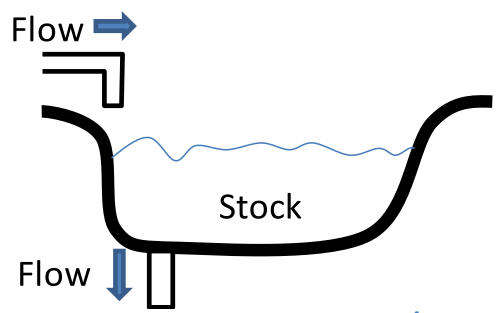

Figure 4-3: Bath Tub System[4]

Figure 4-4: Stock-Flow Diagram of the Bath Tub System

Figure 4-4 presents the same system in a stock-flow diagram that shows the inflows and outflows of the system. The clouds represent sinks, which are stocks that are outside of the system that are infinitely large to provide or accommodate any level of flow (Forrester 1961). These could be the city water supply that provides water to the house and the sewer system that collects waste water. However, these would be outside the boundary of the system and not necessary for the understanding of the system's behavior. One essential aspect of system dynamics is that it deals with the aggregate of components within the system. That is, the

[4] Figure 4-3 adapted from Sterman 2000.

model does not distinguish between individual water molecules in the system or track an individual molecule's path through the system.

4.1.4: Application to Flight School XXI

The remainder of this chapter presents an application of System Dynamics to understand the behavior of the AH-64 Advanced Aircraft Course as one process in the FS XXI Enterprise. The intent of the model is to simulate the observed behavior of the system, in which, the actual course length varies greatly from class to class, to determine the causes of this oscillation. The model incorporates several aspects of the different views of enterprise architecting to gain a holistic view of the process and show how the interactions between the views affect the process. Again, because system dynamics examines components of the system in an aggregate, the model will not examine individual students as they flow through the system or individual courses. These variables are aggregates, so the model's course length variable represents the average course length of the individual courses in session. The intent for the model is to gain a better understanding of the dynamics of the system and to determine policies that can help correct the behavior of the system.

4.2: AH-64 Course

The AH-64 Advanced Aircraft Course trains new aviators on the operation and tactical employment of the AH-64 Apache attack helicopter. The course consists of several phases: transition, instruments, day systems, night and night vision goggles, gunnery, and advanced combat skills. The total course length is 107 days, with 20 simulator days (46.8 Flight Hours), 53 daytime flight days (59.6 Flight Hours), 26 night flight days (29.8 Flight Hours), and the remaining 8 days spent in the classroom (110th AB 2006). Each course consists of a planned student load of 22 students and the course starts every four weeks (USAACE 2009). The course appears straight forward and the FS XXI Enterprise should be able to schedule courses to maximize throughput and efficiently utilize the enterprise's resources utilizing traditional project management tools. However, several feedback loops influence the course that demonstrates how the organization, policy/external influences, strategy, knowledge, and product views influence the process. The next sections describe the casual loops identified in the AH-64 course, which drive the dynamics of the system.

4.2.1: "The Bubble is Bad"

The most evident casual loop in the AH-64 course is the effect that spending excess time in the bubble has on new aviators. As new aviators spend weeks, even months in the bubble, between the IERW common course and the advanced aircraft course, this time degrades their knowledge and they lose their basic aviator skills. Ninety-two percent of instructor pilots surveyed agreed or strongly agreed that the bubble degrades new pilot skills between these courses and eighty-eight percent agreed that they dedicate a significant amount of time to re-teaching these skills (Pilots 2010). So, this increases the amount of time that instructor pilots in the advanced aircraft course have to spend with the new aviators to train all of the required tasks for that aircraft. First, these instructor pilots must re-train the basic aviator skills and then can progress to the tasks in the advanced aircraft program of instruction. This creates several different wastes for the enterprise. First, the excess time spent in the bubble generates re-works. Second, the costs to fly an AH-64 are much higher than the costs to fly the civilian aircraft (TH-67) used for the common course. So the enterprise is spending excess money to train tasks that they could train at a much lower cost using the TH-67 or simulators.

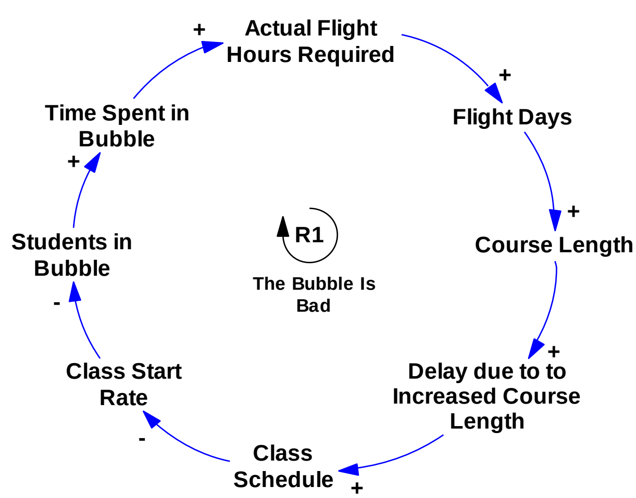

Figure 4-5: Reinforcing Loop 1 – "The Bubble is Bad"

Figure 4-5 presents “The Bubble is Bad” reinforcing casual loop which depicts the effect of time spent in the bubble on new aviators and the course length. As the number of *Students in Bubble* increases, the amount of *Time Spent in Bubble* also increases. The degradation of basic aviator skills because of the time spent between course increases the actual *Flight Hours Required* which in-turn increases the number of *Flight Days* in a course. As more flight days are required for a course, this increases the *Course Length*. Because of fixed resources, if student ability, aircraft maintenance, or weather significantly delays a course, beyond about 2 weeks, the enterprise either cancels or delays subsequent courses. The loop represented this as in increase in *Class Schedule*, which is the time between course start dates. This increase causes the *Class Start Rate* to decrease, because students are entering the course less frequently. Finally, if the courses are not starting as often, this delay increases the number of *Students in Bubble* because students continue to flow into the stock from the common course; however, the delay has decreased the outflow of students beginning the AH-64 course.

4.2.2: “We Need More IPs”

Much like a civilian enterprise’s hiring process, the process for getting new instructor pilots requires the enterprise to request additional instructor pilots from outside the organization. However, there are significant delays from the time the enterprise requests an instructor pilot to the time an instructor pilot arrives at Ft. Rucker. Additionally, a delay exists between the time the instructor pilot arrives, when the Army clasifies the position as filled, and the time the instructor pilot actually begins training students. The new instructor pilots must become certified as instructor pilots and could possibly have to attend additional professional development courses. The wars in Iraq and Afghanistan have amplified this delay because aviators do not have as many opprotunities to attend these required course when assigned to a combat aviation brigade. Also, the instructor pilot course competes with the FS XXI courses for the same resources on Ft. Rucker. Although this appears to be a straight forward process, request additional instructor pilots when required, the delays in the process create problems within the system.

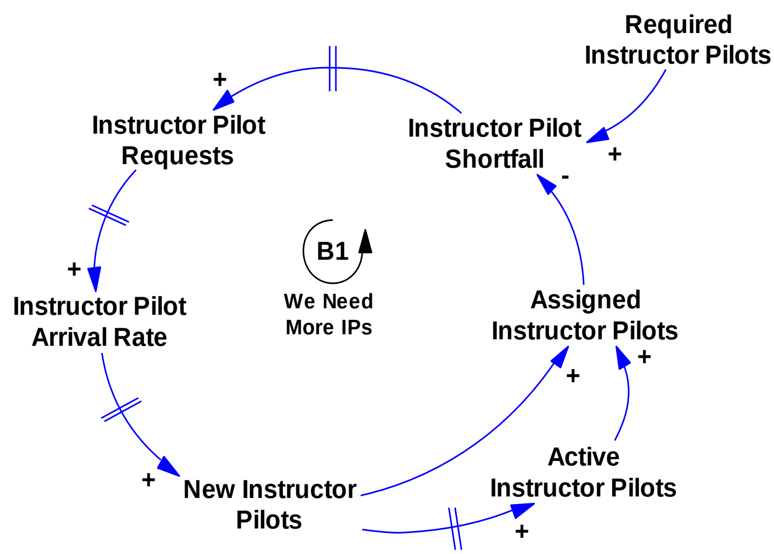

Figure 4-6: Balancing Loop 1 – "We Need More IPs"

Figure 4-6 presents the balancing loop, "We Need More IPs" which describes the process for requesting additional instructor pilots. First, the difference between the *Required Instructor Pilots* and the *Assigned Instructor Pilots* determines the *Instructor Pilot Shortfall*. As this is a balancing loop, the system will attempt to achieve equilibrium at the level of *Required Instructor Pilots*. As this shortfall increases, the enterprise increases the *Instructor Pilot Requests* after a short delay to realize there will be a shortfall and process the requests through the Army's Human Resources Command. After the requests increase, the *Instructor Pilot Arrival Rate* increases, again after a delay for Human Resources Command (HRC) to identify a potential candidate and process the aviator's Permanent Change of Station (PCS) orders. After a delay, for the instructor pilot to move from their current post to Ft. Rucker, this increases the stock of *New Instructor Pilots.* The arrival of a new instructor pilot at Ft. Rucker immediately increases the number of *Assigned Instructor Pilots*, so HRC considers the instructor pilot position as filled. However, there is a delay between a new instructor pilot arriving and becoming an *Active Instructor Pilot*. The delays that exist in this feedback loop will cause instability in the system and the FS XXI Enterprise should address them to create a stable stock of *Active Instructor Pilots.*

4.2.3: “Fly More Often”

One of the options the enterprise has to get a delayed course back on schedule is to fly on Saturdays. If a course is significantly behind schedule, the enterprise can elect to add an additional flight day to the week. However, this costs the enterprise a lot of money as they pay contracted maintainers and employees overtime to accommodate the additional flight day. The model does not directly calculate the cost; however, it does track the number of days flown per week, so one could extrapolate the additional costs. Additionally, this puts increased stress on the aircraft which require maintenance every 750 hours (AFS 2009). Also, regulations limit the number of flight hours that instructor pilots can fly during a 30 day period (1-14 Avaition Regiment 2008). So by adding additional days, an instructor pilot could reach this limit and have to rest when they could be flying students.

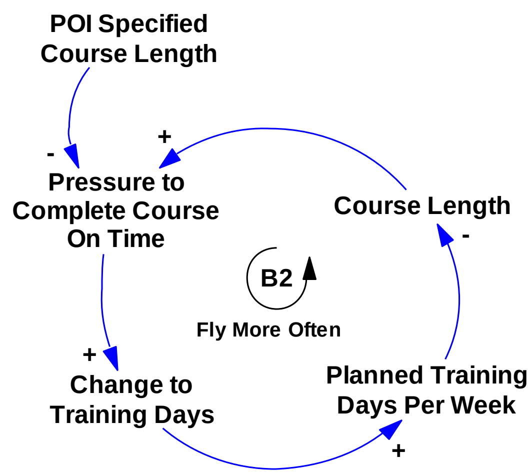

Figure 4-7: Balancing Loop 2 – “Fly More Often”

Figure 4-7 presents the “Fly More Often” balancing loop. When the *Course Length* increases past the *POI Specified Course Length,* this creates *Pressure to Complete Course on Time.* As this pressure increases to a certain point, where the enterprise can no longer complete the course by flying a little extra every day, the enterprise increases the *Change to Training Days*. This increases the *Planned Training Days per Week* from 5 days to 6 days, which represents flying on Saturday. By flying an additional day per week, the enterprise is able to decrease the *Course Length* and the balancing loop returns the course length to the scheduled course length.

4.2.4: "Too Many Students for the IPs"

Another issue that affects the FS XXI Enterprise is the student to instructor pilot ratio. Ideally, there is one instructor pilot for every two students; however, the situation might dictate that as many as three students per instructor pilot. The fixed flight window of three hours per day causes the course length to increase when the student to instructor pilot ratio is greater than two. This causes delays in training and affects the ability of instructor pilots to graduate students on time.

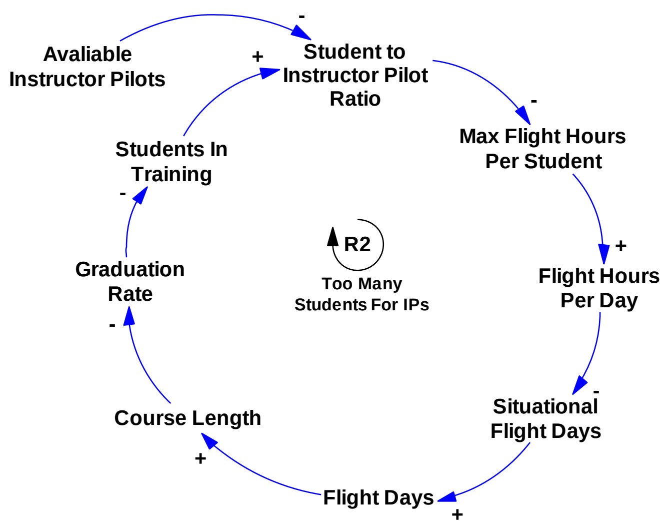

Figure 4-8: Reinforcing Loop 2 – "Too Many Students for IPs"

Figure 4-8 presents this reinforcing feedback loop that explains how an increase the student to instructor pilot ratio affects the course length. As the number of *Students in Training* increases, the *Student to Instructor Pilot Ratio* increases, assuming that the *Available Instructor Pilots* remain the same. This decreases the *Max Flight Hours per Student* from 1.5 hours per day which also decreases the number of *Flight Hours per Day* actually flown. Because the students are flying less per day, the *Situational Flight Days*, days flown in addition to the scheduled flight days, and the *Flight Days* increase. The increase in the *Flight Days* causes the *Course Length* to increase which decreases the *Graduation Rate*. The fewer students graduating increase the number of *Students in Training* which then increases the *Student to Instructor Pilot Ratio*. So, this feedback loop shows how not having enough Instructor Pilots for the number of students can create a snowball effect and cause even greater delays. Also, one can infer that if the number of students were regulated based on the number of instructor pilots, these delays could be prevented.

4.2.5: "Fly the Wings Off"

The "Fly the Wings Off" reinforcing feedback loop is the largest loop affecting the FS XXI Enterprise and is difficult to identify because of the length of time between cause and effect in this loop. In addition to daily preventative maintenance, helicopters require extensive phase maintenance every 750 flight hours, during which maintainers spend about three weeks repairing the helicopter. The current maintainers are able to process six helicopters at a time with a completion rate of about two helicopters per week (AFS 2009). This means that the enterprise can only fly 1500 flight hours per week without exceeding the current capabilities of their maintainers. However, the "Fly More Often" feedback loop causes the instructor pilots to want to fly more often, which could trigger this feedback loop. Also, this limits the number of planned flight hours per day to a certain level.

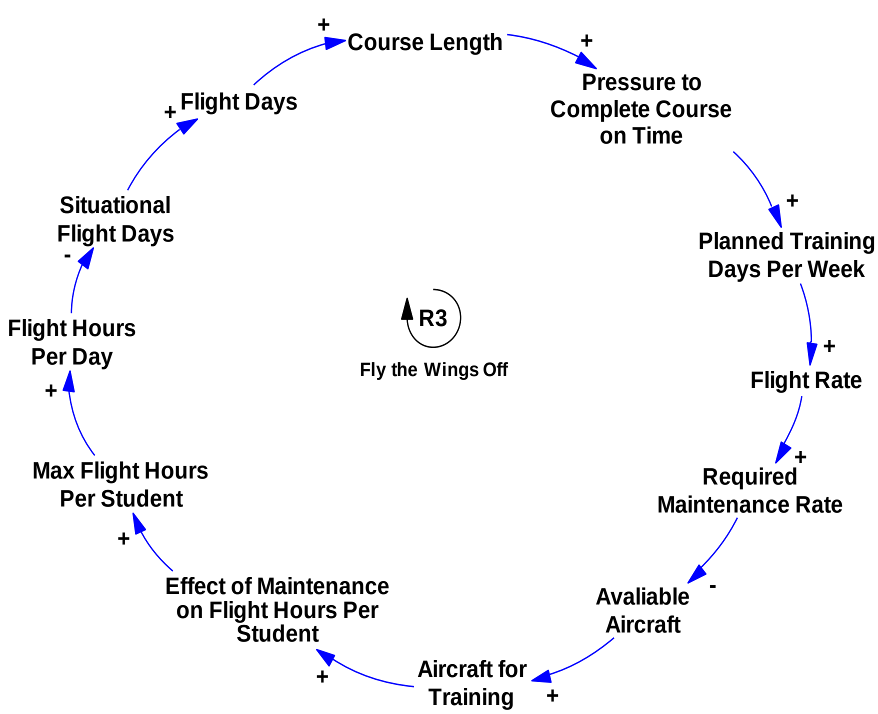

Figure 4-9: Reinforcing Loop 3 – "Fly the Wings Off"

Figure 4-9 presents the reinforcing feedback loop that explains this systemic problem of flying in excess of what maintenance can provide. Beginning at the top of the figure, an increase in the *Course Length* increases the *Pressure to Complete Training on Time* which in-turn increases the *Planned Training Days per Week* and the *Flight Rate.* As the *Flight Rate* increase, the additional flight hours increase the *Required Maintenance Rate*. Because these helicopters now require maintenance, this decreases the number of *Available Aircraft* and *Aircraft for Training*, which is a percentage of available aircraft to account for unscheduled maintenance. This causes an *Effect of Maintenance on Flight Hours per Student* which also decreases the *Max Flight Hours per Student.* This decrease also causes the *Flight Hours per Day* to decrease, which increases the number of *Situational Flight Days.* Like the previous loop, this increases the number of *Flight Days* required and extends the *Course Length*.

A major concern of this loop is that the cause and effect of the feedback loop occur over a very long period. Because aircraft are on different maintenance schedules, it would take several months of flying in excess of 1500 hours to cause a noticeable effect on the number of aircraft available for training. It is likely that the symptoms of this feedback loop would begin presenting as a few aircraft awaiting phase maintenance. However, these aircraft, which instructor pilots are not using for training or maintainers actively repairing, decrease the number of available aircraft, which means that students are flying fewer aircraft, more often. This could cause exponential growth of aircraft awaiting phase maintenance and would eventually create a complete breakdown of the system.

4.3: AH-64 Course Model

The model of the AH-64 advanced aircraft course uses System Dynamics as a tool to simulate the interactions between the process view, the focus of the model, and the other views of Enterprise Architecture. The intent of the model is to simulate the AH-64 course for 3 years (156 months) to determine how a bubble developed and what causes the course delays. To calibrate the model, the initial simulation of the model extends the course length to about 25 weeks, which is consistent with the available data. Additionally, the model shows how the strategy, organization, knowledge, product, and policy/external factors views influence the process view. The model accounts for the feedback loops identified above and demonstrates how the views impact the process of training aviators. Figure 4-10 presents the current graphical depiction of the interactions between the Enterprise Architecture Views based on a frame Nightingale and Rhodes developed (2007). In addition to these views, the model demonstrates a link between the external factors and the process views. Appendix C contains the complete model and variable list categorized by Enterprise Architecture View.

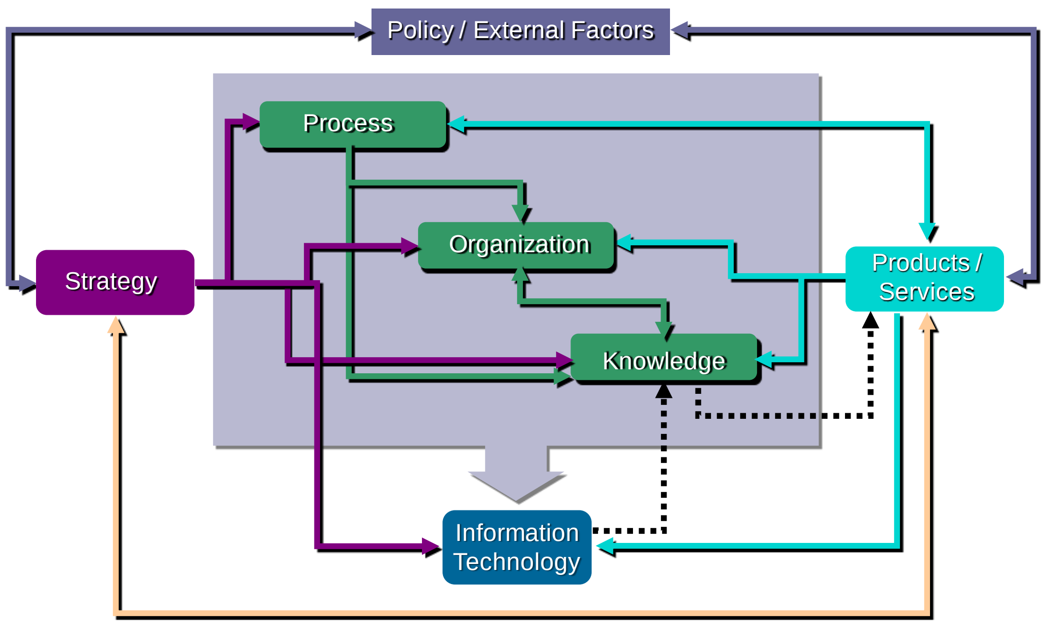

Figure 4-10: Interactions of Enterprise Architecture Views (Nightingale and Rhodes 2007)

4.3.1: Model Structure

The model uses the five feedback loops from Section 4.2 as a base for the structure of the stocks and flows. The basic structure of the model is a two-stage growth model in which the students progress from the IERW Common Course, to the AH-64 Bubble, then to training, and finally they graduate from the AH-64 advanced aircraft course. Figure 4-11 presents a portion of the model that represents the process view of the enterprise. In addition to the process view, this portion of the model includes portions of the strategy view of the enterprise. The *Whitebook Specified Class Schedule, POI Specified Course Length, POI Required Flight Hours, and Class Capacity* variables are FS XXI's goals and objectives, which is a component of the strategy view. The model also includes a part of the product view, as it accounts for the *Effect of bubble on Flight Hours*, which is the variable that increases the required flight hours per student and a part of “The Bubble is Bad” feedback loop. This simulates the degradation of aviator skills as students spend time awaiting training in the bubble, similar to inventory becoming obsolescent.

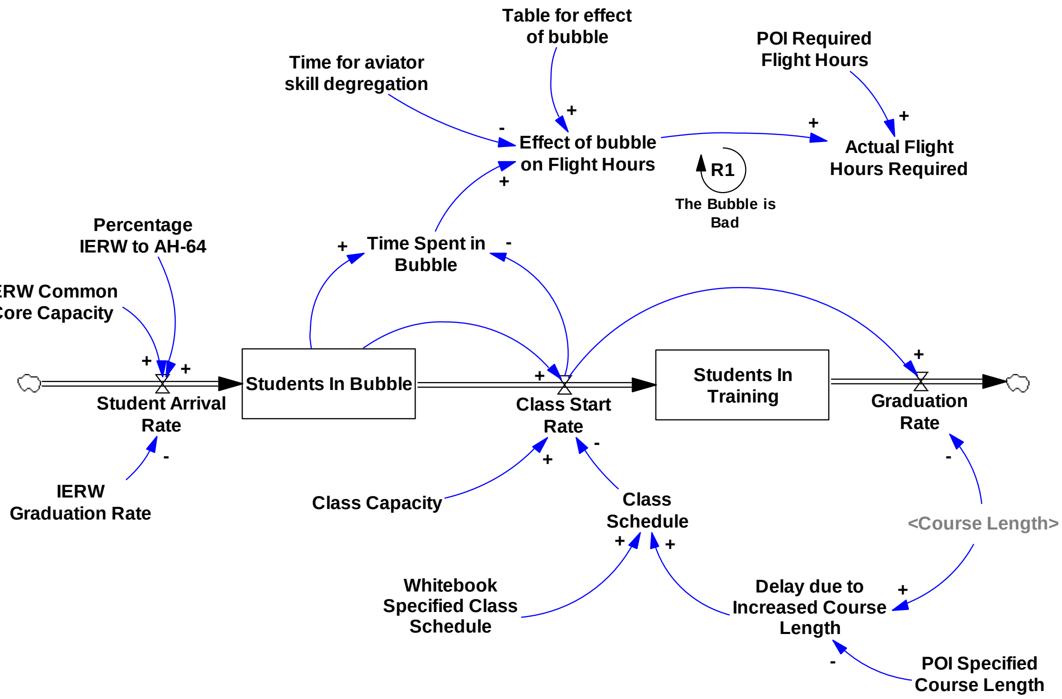

Figure 4-11: AH-64 Model – Student Sub-Model

There are two aspects of the organization of the FS XXI Enterprise that effect the process of training aviators. First, the instructor pilots are an essential component of the organization that directly affects the process view. Although the USAACE designed the organization to support training for the number of students dictated by the enterprise’s strategy, the Army cannot always fully staff the organization, which impacts the training process. Additionally, there is a knowledge aspect to the instructor pilots which affects the number of instructor pilots available to train students. As new instructor pilots arrive at Ft. Rucker, there is a delay until they can train students because they have to gain knowledge as instructors for FS XXI. Figure 4-12 presents the instructor pilot component of the organization view including the knowledge aspect depicted by the *Instructor Pilot Training Rate* variable.

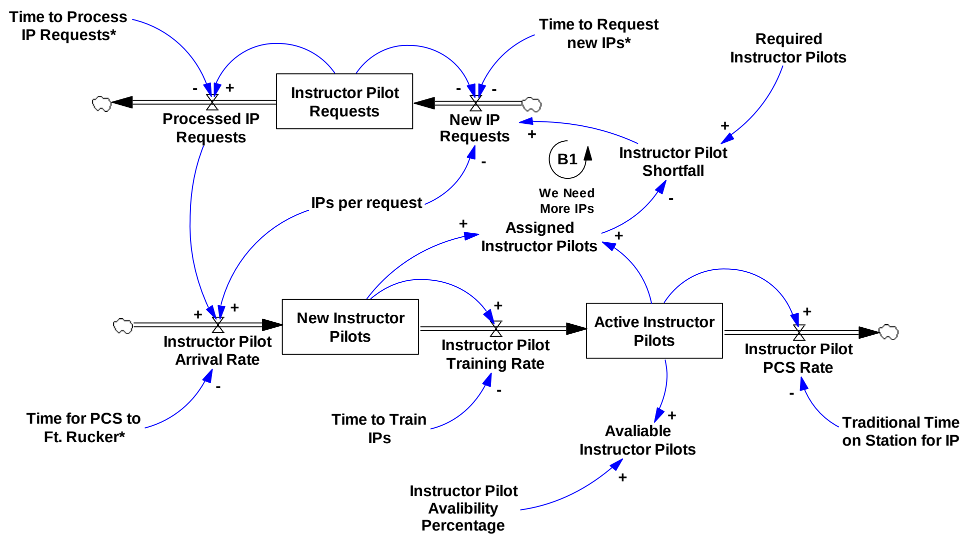

Figure 4-12: AH-64 Model – Instructor Pilot Sub-Model

The other aspect of the organization that directly impacts the training process is the number of aircraft in the enterprise and the maintenance of these aircraft. Figure 4-13 presents this portion of the model which represents the “Fly the Wings Off” feedback loop. This impacts the training process through the *Effect of Maintenance on Flight Hours per Student* which accounts for when aircraft are not available because of maintenance. Additionally, aspects of the Policy View directly affect this portion of the model in that Army policies regulate the number of flight hours an aircraft can fly between scheduled phase maintenance. Also, the FS XXI Enterprise’s strategy affects this portion of the model through the *Flight Hours per Day* and *Planned Training Days per Week* which also directly impacts the training process.

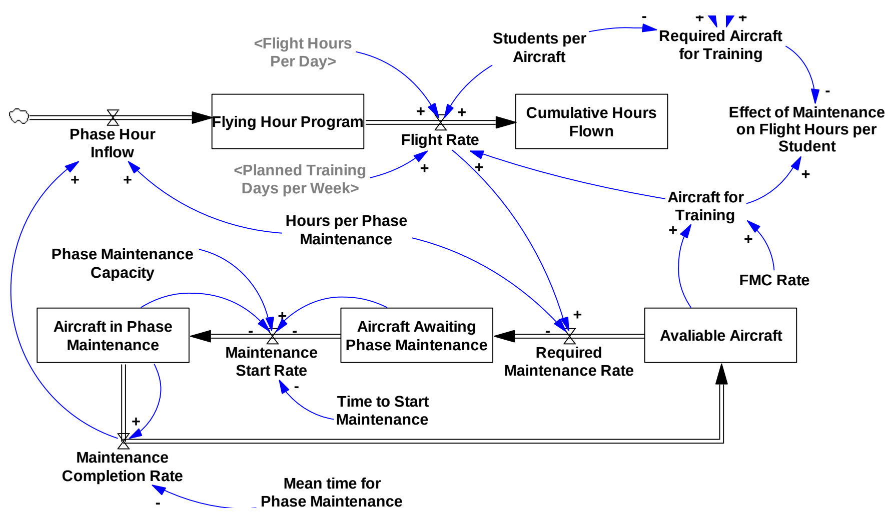

Figure 4-13: AH-64 Model – Maintenance Sub-Model

Weather is the main external factor that directly impacts the training process in the FS XXI Enterprise. The nature of the training requires good weather for the days that the POI specifies as *Flight Days*, which comprise a majority of the course. In the model, the *Weather Day* variable is a random normally distributed variable with a mean of 0.962 and a standard deviation of 0.929, derived from two years of historical data (ACLC 2009). When the model determines that weather would affect training for the day, it adds an additional flight day to the course length. However, the model allows instructor pilots to make up these weather days by flying additional hours, up to the maximum flight hours for the day. The *Change to Flight Days* flow from the stock of *Flight Days* accounts for instructor pilots flying additional hours to make up weather days.

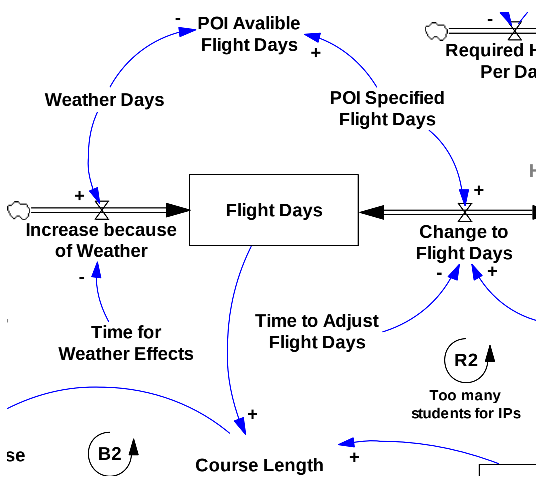

Figure 4-14: AH-64 Model – Course Length Sub-Model

4.3.2: AH-64 Initial Simulation

The intent of the initial simulation was to simulate an increase in course length, similar to the increase in course length found in historical data from the Status of Flight Line Reports, and generate a bubble of students awaiting the course. Although a precise calibration to the historical data would be ideal, the behavior of the system provides valuable insights into the dynamics of the AH-64 Advanced Aircraft Course. The initial simulation utilizes current values from the FS XXI Enterprise as initial conditions for the model to represent the actual performance of the course.

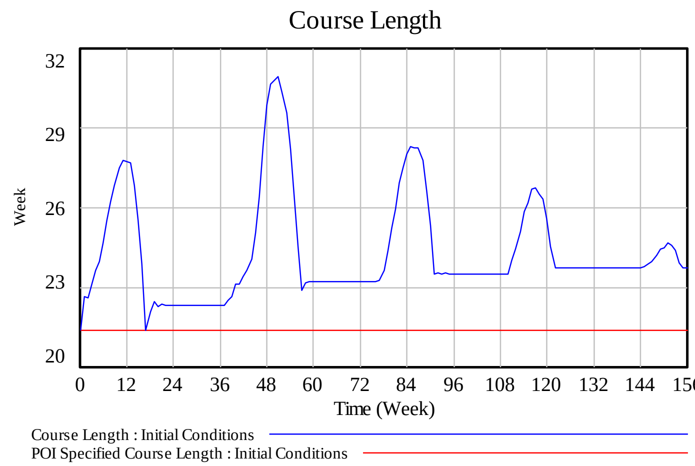

Figure 4-15: AH-64 Initial Simulation – Course Length

Figure 4-15 presents the *Course Length* variable from the AH-64 Model with the initial conditions. The model generates an increase in course length, which aligns with the actual data from the enterprise. Also, the course length, shown in blue in the figure, is constantly above the POI specified course length, shown in red. This behavior is very similar to the actual course length recorded by the enterprise. Figure 4-16 presents the actual course length of the AH-64 Advanced Aircraft Course from April to October 2009. Although this data is only from a few months, whereas the model is for three years, the behavior is similar. The actual data shows a spike in course length, followed by a brief period of stability at a longer course length than specified by the POI.

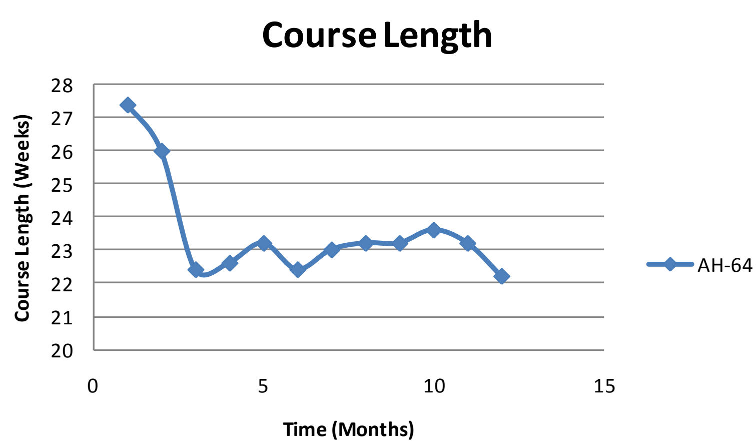

Figure 4-16: AH-64 Course Length - APR 09 to OCT 09 (110th Aviation Brigade 2009)

Additionally, the model generated a bubble of students awaiting training which reaches current levels of students awaiting the AH-64 Advanced Aircraft Course. This is an important aspect of the model because it demonstrates that a bubble could occur as a result of the feedback looks in the system and not a result of some external factor that is uncontrollable by the FS XXI Enterprise. Also, Figure 4-18 presents the number of students in training at any time, again this stock shows an oscillating behavior, which demonstrates that increased course length is delaying course starts and impacting throughput. This aspect of the model is very important because it impacts the throughput of the course, which means the enterprise will fail to meet their objective of producing 1200 aviators per year.

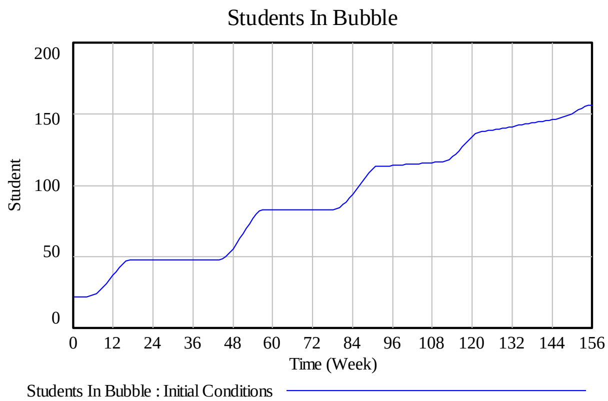

Figure 4-17: AH-64 Initial Simulation – Student Bubble

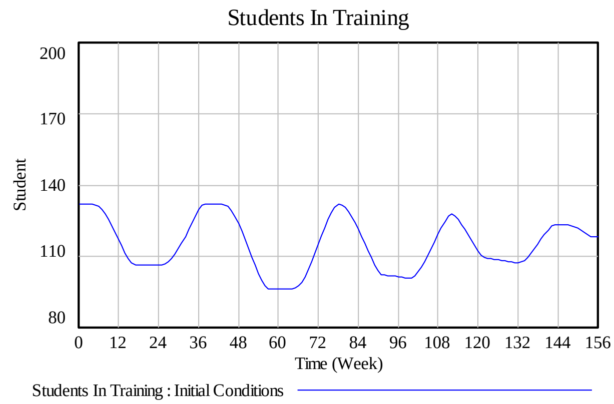

Figure 4-18: AH-64 Initial Simulation – Students in Training

Overall, the initial simulation of the model appears to successfully represent the actual behavior of the AH-64 Advanced Aircraft Course. The actual course length varies and is consistently greater than the POI specified course length. The model generates a bubble of students awaiting training, the main problem facing the FS XXI Enterprise. Finally, the model affects the throughput of the process to the point that the enterprise is unable to meet their goals of training 1200 aviators per year. The model is a good starting point for evaluating potential courses of action to stabilize the course length and correct the problems of the course.

4.3.3: Insights from the Model

The main insight from the model is the impact that the *Student to IP Ratio* variable has on the course length. When the ratio is greater than two to one, the course length begins to increase. Further analysis identified that this is because instructor pilots are unable to make up weather days with the internal buffer because they cannot fly the maximum of 1.5 hours per day per student. Figure 4-19 presents the results of the initial simulation and shows how the *Student to IP Ratio* impacts the *Course Length*.

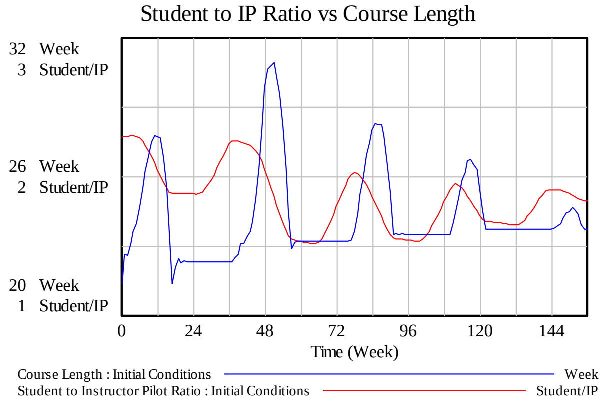

Figure 4-19: AH-64 Initial Simulation – Student to IP Ratio vs. Course Length

Table 4-1 presents calculations which demonstrate how an increased student to instructor pilot ratio can impact the maximum number of hours flown per week and how weather can create a deficit of flight hours. If there is no weather, instructor pilots are able to fly the POI required 1.2 hours per day and complete the 6 flight hours for the week. If the Student to IP ratio is at the desired two to one ratio and there is a weather day, the instructor pilots are able to fly 1.5 hours per day per student and complete the required 6 flight hours of training. However, if the Student to IP ratio is at three to one and there is a weather day during the week, the instructor pilots are only able to fly 4 hours and have a 2 hour deficit, which would take two weeks of perfect weather to make-up for the lost training time. This is an important insight gained by modeling the process, because it identifies two of the possible causes for increased course length. First, it shows the direct impact of flying three students for every instructor pilot, which even if there were no weather days would only allow the instructor pilot to train each student for 5 hours per week, leaving a 1 hour deficit. And second, it demonstrates how the student to instructor pilot ratio multiplies the impacts of weather days.

Daily Flight Hours per Student	M	T	W	Th	F	Total	Deficit
POI Required	1.2	1.2	1.2	1.2	1.2	6.0	
Maximum 2:1 IP Ratio	1.5	1.5	1.5	1.5	1.5	7.5	
Flown (No Weather, 2:1 IP Ratio)	1.2	1.2	1.2	1.2	1.2	6.0	0.0
Flown (No Weather, 3:1 IP Ratio)	1.0	1.0	1.0	1.0	1.0	5.0	1.0
Flown (Weather, 2:1 IP Ratio)	0	1.5	1.5	1.5	1.5	6.0	0.0
Flown (Weather, 3:1 IP Ratio)	0	1.0	1.0	1.0	1.0	4.0	2.0

Table 4-1: Impact of IP Ratio on Hours Flown

4.4: Courses of Action

The FS XXI Enterprise could take several possible courses of action to improve the performance of the AH-64 training process. These courses of action could include modifications to the process, organization, or strategy view of the enterprise. The purpose of these modifications is to stabilize the course length and create a constant flow of students through the system. In order to create a constant flow of students through the entire FS XXI Enterprise, all of the courses of action reduce the batch size of students to 11 and begin every 2 weeks to align with the output of the IERW Common Course. FS XXI would have to actually increase the batch size to 12, because students train in teams of two, but for the simulation, it remains at 11 to ensure consistency with the initial run of the simulation. The four courses of action are: 1) to increase the number of aircraft; 2) increase the number of instructor pilots; 3) increase the daily flight period; and 4) add weather days to the Program of Instruction (POI).

4.4.1: Increase the Number of Aircraft

This course of action evaluates increasing the number of aircraft available for the enterprise. In this course of action, the model simulates a 10% increase in aircraft by increasing the *Available Aircraft* variable from 50 to 56 aircraft. This should reduce the *Effect of Maintenance on Flight Hours per Student* by increasing the number of aircraft and reducing the effect of unscheduled maintenance on training. The thought behind this course of action is that by increasing the number of aircraft there will be a larger pool of aircraft to draw from for training. With a constant fully mission capable (FMC) rate, more aircraft that are available will lead to more aircraft for training. The enterprise requires approximately 50 A*ircraft for Training* per day and the current *FMC Rate* is approximately 79% (ACLC 2009). If there are only 50 aircraft available for training and only 79% of these are FMC, this creates a deficit of *Aircraft for Training* which impacts the *Maximum Flight Hours per Day*. If the enterprise increases the number of *Aircraft Available*, they will reduce the impact of unscheduled maintenance on training.

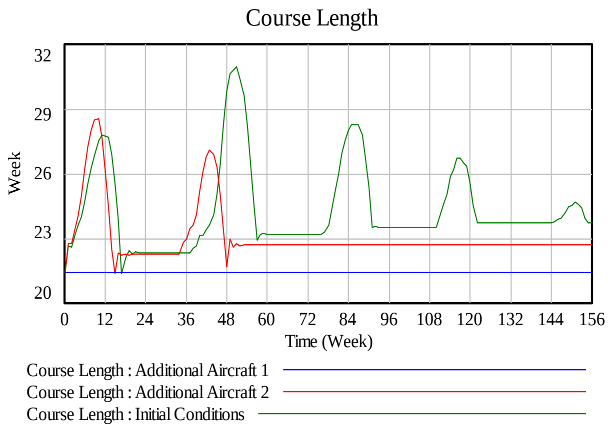

Figure 4-20: Increase in Aircraft – Course Length

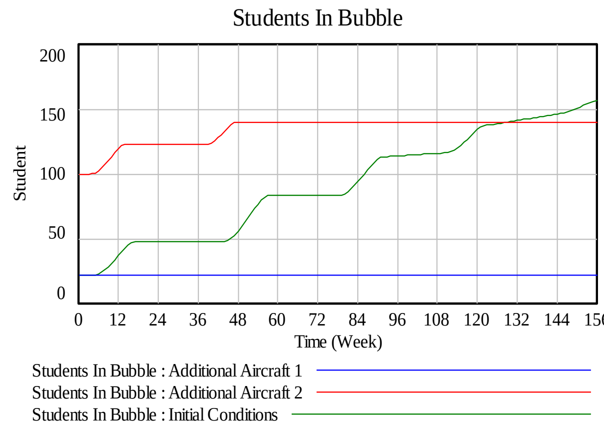

Figure 4-21: Increase in Aircraft – Bubble

Initially this course of action appeared to be successful at stabilizing the *Course Length* and maintaining a steady stock of *Students in Bubble.* Figure 4-20 and Figure 4-21 present the output from this simulation. In each of the figures, the blue lines represent the initial simulation with the increased number of *Aircraft Available*. The Initial Conditions and the Additional Aircraft 1 simulations assumed that the initial value for the bubble was only 22 students. However, the current bubble is approximately 100 students and any simulated policy change would have to consider this bubble (1st Aviation Brigade 2009). So, the Additional Aircraft 2 simulation sets the *Students in Bubble* variable to 100. In this case, this course of action does not succeed in stabilizing the *Course Length* or maintaining a constant stock of *Students in Bubble*. Additionally, this course of action may have complications in implementation as the USAACE competes with the operational Army for a limited number of AH-64 aircraft as resources. So, a course of action that recommends increases the number of aircraft would require better performance than that simulated by this model.

4.4.2: Increase the Number of IPs

This course of action evaluates increasing the number of instructor pilots within the enterprise. In this course of action, the model simulates an addition of 11 new instructor pilots into the system. It assumes that HRC could immediately supply the USAACE with the additional instructor pilots. However, these new instructor pilots would still have to attend the Instructor Pilot Course, so they would not be initially be available to train students.

The intent of this course of action is to decrease the effects of a student to instructor pilot ratio of greater than two to one. If the student to IP ratio is two to one, then instructor pilots can fly a maximum of 1.5 hours per day and can complete the POI specified flight hours, 89.4 hours, in 59.6 days. Given the 79 flight days specified in the POI, this provides instructor pilots with a 19.4 day buffer. However, if the student to IP ratio is three to one, then the instructor pilots can only fly a maximum of 1.0 hours per day per student. Under these conditions, instructor pilots can complete the POI specified flight hours in 89.4 days. This exceeds the POI specified course length by 10.4 days and the extended course length will begin to affect follow-on courses. So, by providing the enterprise with additional instructor pilots, this course of action attempts to correct this problem to stabilize the course length.

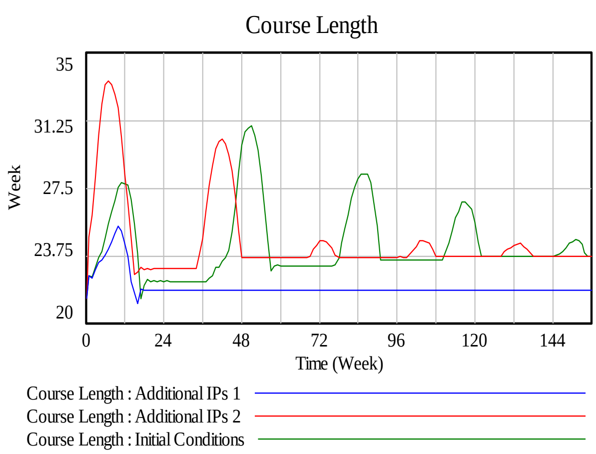

Figure 4-22: Increase IPs– Course Length

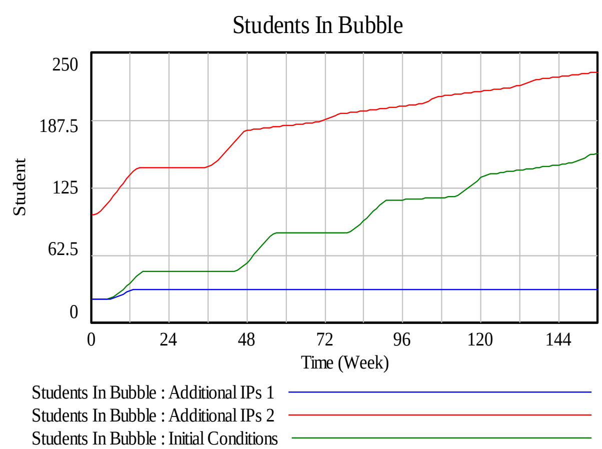

Figure 4-23: Increase IPs –Bubble

The simulation for this course of action performed as expected because of the delay required to train the new instructor pilots. Figure 4-22 presents the course length results for this simulation and Figure 4-23 presents the bubble results. The first simulation, which assumed the bubble began at 22 students, showed an initial increase in the course length due to the time required to train the increased number of new instructor pilots. The figures show this simulation in blue. After the new instructor pilots complete training, the course length reaches an equilibrium at 21.8 weeks, slight longer than the planned course length, but not large enough to affect follow-on courses. However, the second simulation, which used an initial bubble of 100 students, performed worse than the initial simulation with no changes. The red line in the figures shows the results of this simulation, in which the course length varies greatly and the bubble increases drastically. Although it appears that increasing the number of instructor pilots should improve the performance of the enterprise, the model results to not support this when the initial conditions of the simulation are at current levels.

4.4.3: Increase the Daily Flight Period

For this course of action, the model evaluates increasing the daily flight period to provide the instructor pilots with a longer window to train students per day. This increases the *Flight Hour Window per Day* from 3 hours to 3.5 hours per day. This enables instructor pilots to fly a maximum of 1.75 hours per student per day and should mitigate the effects of weather, maintenance, and a lack of instructor pilots. Similar to the other course of action, this simulation utilizes a smaller batch size of students and decreases the time between class starts to two weeks.

The hypothesis behind this course of action is that providing the instructor pilots with additional time to train students will allow them to make-up any training missed due to weather or maintenance. However, the limitations of the maintenance system and the instructor pilot flight hour limitations constrain this course of action. At the current maintenance level, the maintainers complete phase maintenance on two aircraft per week, which increases the flight hour program by 1500 hours per week (AFS 2009). This constrains the instructor pilots to 1500 flight hours per week; otherwise, the maintenance system will develop a backlog of aircraft awaiting phase maintenance. Additionally, the current contract states that Army Fleet Support will provide the USAACE with 85 sorties per day based on the current number of aircraft assigned (AFS 2009). If instructor pilots are able to fly all sorties, five days a week, there will be 425 sorties per week. So, given the maintenance limits, the maximum flight time per sortie is 1500/425 or 3.5 hours per sortie. Additionally, instructor pilots are constrained to fly a maximum of 85 hours in a 30 day period. (1-14 Avaition Regiment 2008) Assuming pilots only fly during the regular work week, an instructor pilot will fly approximately 22 days per 30 day period. The instructor pilots limit the daily flying hour period to 3.8 hours per day.

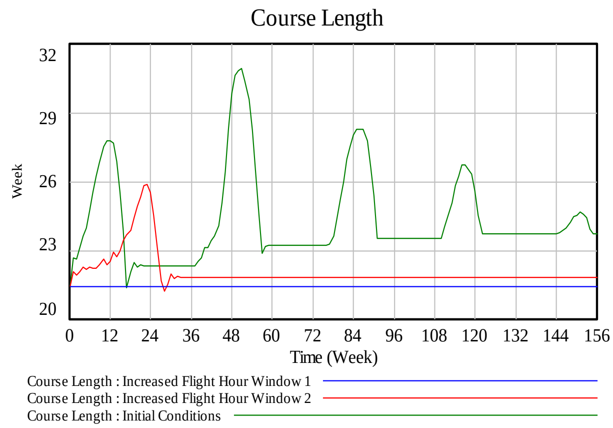

Figure 4-24: Increase Flight Hours – Course Length

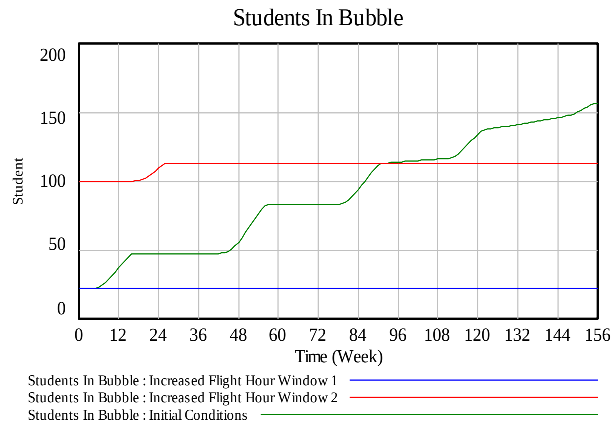

Figure 4-25: Increase Flight Hours –Bubble

Again, this course of action demonstrated positive results when the initial bubble included only 22 students. In this simulation, the course length stabilized at 21.4 weeks for the duration of the simulation and the stock of *Students in Bubble* remained constant at 22 students. However, when the initial value of *Students in Bubble* is 100 students, the current level, the course length increased to about 26 weeks and the bubble increased slightly during this time as the red line represents in Figure 4-24 and Figure 4-25. Additionally, the course length reaches equilibrium at about 22 weeks, which is greater than the planned course length of 21.4 weeks. So, this course of action appears to be promising and the FS XXI Enterprise could implement this course of action because it only requires changes internal to the enterprise.

4.4.4: Add Weather Days

In this course of action, the model evaluates the addition of 5 weather days to the POI and adding a one week buffer at the end of the course to account for weather days. This increases the *Course Length* to 22.4 week and the number of *POI Specified Flight Days* to 84; however, the *POI Required Flight Hours* remain the same as the initial conditions. Also, the buffer at the end of the course requires the enterprise to schedule three weeks in between the end of one course and the beginning of the next course for each team of instructor pilots. This provides each team of instructor pilots with an additional 5 days of possible training if the weather is extremely bad and maintains two weeks to complete additional tasks before beginning a new course.

The hypothesis behind this course of action is that instructor pilots do not have adequate time to make up training lost because of weather days. Although the POI currently accounts for weather days by only requiring an average of 1.2 flight hours per day out of 1.5 flight hours available, this is not adequate if weather affects more than one day per week. On average, weather affects one day per week, plus or minus one day. So, given the current POI, which has 15.8 weeks of flight training, weather could affect between 0 and 31.6 days, with an average of 15.8 days per course. This equates to 63.2 days actual available to train students for 1.5 hours per day or 94.8 available flight hours. So, if the weather is average during a course, the instructor pilots are able to make up the training missed due to weather, and have an additional 5.4 flight hours for a buffer. This assumes that the student to instructor pilot ratio remains at 2 to 1 and allows for a full 1.5 hour flight window per day. However, the worst case scenario, in which two days per week are lost to weather, only allows instructor pilots to fly 71.1 hours, which leaves them with an 18.3 hour deficit to complete the required 89.4 hours specified by the POI. Instructor pilots would require an additional 12.2 days of good weather to complete the course. The system is able to correct itself and complete the POI as scheduled until there are 19.4 days of bad weather which cancels training. It is likely that that this could occur, especially during the winter months, which traditionally have worse weather.

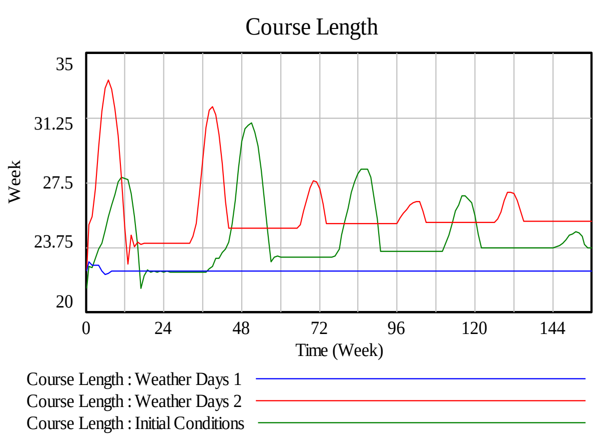

Figure 4-26: Add Weather Days – Course Length

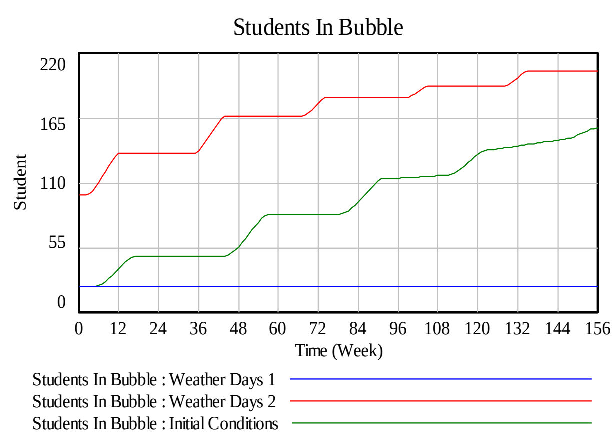

Figure 4-27: Add Weather Days – Bubble

Again, this course of action initially appeared to have promising results. Figure 4-26 presents the course length for this course of action vs. the initial conditions and Figure 4-27 presents the students in the bubble for the simulation. In the Weather Days 1 simulation, identified by the blue line in the figures, there appears to be a slight variation in course length in first weeks of this simulation then, the system quickly reaches equilibrium and maintains a constant course length of 22.4 weeks, which is the planned length with the addition of weather days. Additionally, even with the slight variation to the course length, the number of students in the bubble remains constant at 22, which is the buffer required to ensure that all classes begin with enough students. However, the red line presents the outcome of the simulation when the initial value of the bubble is set at 100 and the course of action does not perform well. So, this course of action alone does not present a very good option for improving the performance of the enterprise.

4.4.5: Recommended Course of Action

Although none of the initial courses of action provided increased performance when the initial conditions represented current bubble levels, the process provided valuable insights to develop a combined course of action for implementation. The recommended course of action is for the enterprise to add weather days and increase the daily flight hour window. In this simulation, the model simulates an additional five days for weather within the course, a five day buffer between courses, and increases the daily flight hour window to 3.5 hours. A benefit of this course of action is that if the USAACE can implement the course of action through internal policy changes. An addition of aircraft or instructor pilots would require organizations external to the enterprise to provide the USAACE with additional resources which are being used by operational units preparing for a deployed to Iraq and Afghanistan. So, the best course of action would be for the USAACE to stabilize the course length and maintain a steady stock of students in the bubble with internal policies.

The results of this combined course of action were very positive as the course length remained constant at 22.4 weeks throughout the simulation and the number of students in the bubble did not change. Similar to the other course of action, the model used an initial bubble of 100 students to simulate the current state of the AH-64 bubble. Figure 4-28 presents the results for the course length for this simulation, blue line, as well as adding weather days, red line, and increasing the flight hour window, green line. As Figure 4-28 shows, the recommended course of action provides the enterprise with a stable course length which is essential for maintaining a continuous flow of students through the process. This is evident in Figure 4-29, which shows a constant bubble of students and demonstrates how the system will operate in equilibrium.

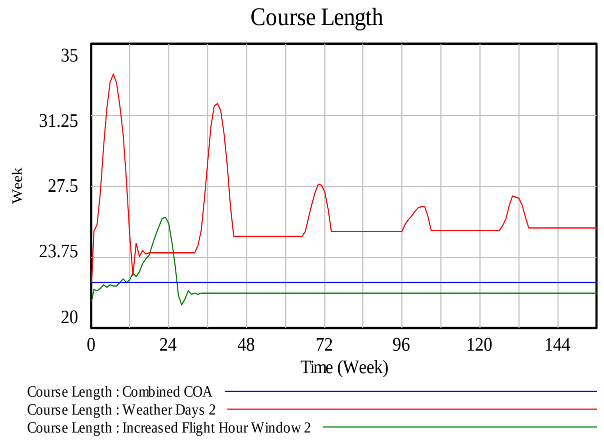

Figure 4-28: Recommended COA – Course Length

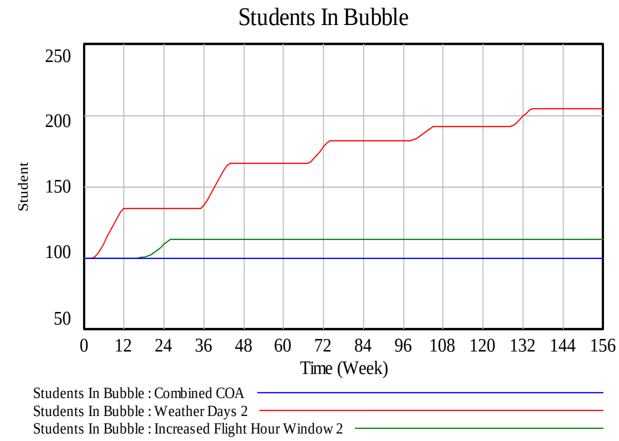

Figure 4-29: Recommended COA –Bubble

With a stable process of training students, the enterprise has the ability to attack the problem of the bubble before the AH-64 course. The bubble of students between the common course and the advanced aircraft courses is nothing more than a bathtub, so to lower the level of the bathtub one can either decrease the water flowing into the tub or increase the water flowing out of the tub. The FS XXI Enterprise can decrease the inflows into the AH-64 Advanced Aircraft Course Bubble by reducing the number of students that graduate from the common course. This would be similar to turning off the faucet in the bathtub example to prevent water from spilling out of the bathtub. Alternatively, they could increase the outflow of the course by increasing the number of students per class. This would be like increasing the size of the bathtub's drain to increase water flow. So, because the addition of weather days and increasing the flight hour period stabilized the training process, the FS XXI Enterprise can now address the problem of reducing the bubble.

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Chapter 5: Future State Architecture

This chapter presents the recommended future state for the Flight School XXI (FS XXI) Enterprise along with an evaluation of the proposed future state compared to the current state. The architecture focuses on the process view of the enterprise. The enterprise currently views the process of training aviators as the most important view. So, the future state architecture presented heavily focuses on the process view. However, the chapter also presents impacts of the architecture on some of the other views, including the strategy, organization, and information technology views. The first section presents the proposed architecture; the second section provides recommendations to achieve the architecture and an implementation plan; the third section provides an evaluation of the proposed architecture; and the final section presents the possible impacts on the other enterprise architecture views.

5.1: Future State Process Architecture

The vision for the future state process architecture is a stable training process that delivers value to the enterprise stakeholders. The new process architecture is more robust, scalable, flexible, and adaptable than the current state value stream. The main component of the future state architecture is the value stream map, which depicts how the FS XXI Enterprise creates value.

The proposed future value stream map incorporates continuous flow of students through training once they begin the BOLC B courses. The value stream map accomplishes continuous flow by eliminating the bubbles of students between the different courses within the training process. In the new value stream, the architecture reduces the batch size of students in the advanced aircraft courses and aligns the start of these courses to the completion of the common course. This alignment ensures that students will continuously flow through training once they begin. However, feeder buffers exist between the different courses to ensure that the FS XXI Enterprise executes every class at capacity. A feeder buffer is a small queue before a process that ensures that the subsequent process will operate at full capacity if something disrupts the upstream flow (Goldratt 1984). These buffers account for students being unable to participate in the next phase of training because of illness or other reasons.

With the buffer, a group of students is always awaiting the start of the next course so the enterprise does not lose any capacity because they do not have students to train. The buffers should be less than the capacity of one course, for example, the AH-64 feeder buffer should be less than 16 students. This ensures that a student will not spend longer than two weeks in a buffer awaiting training.

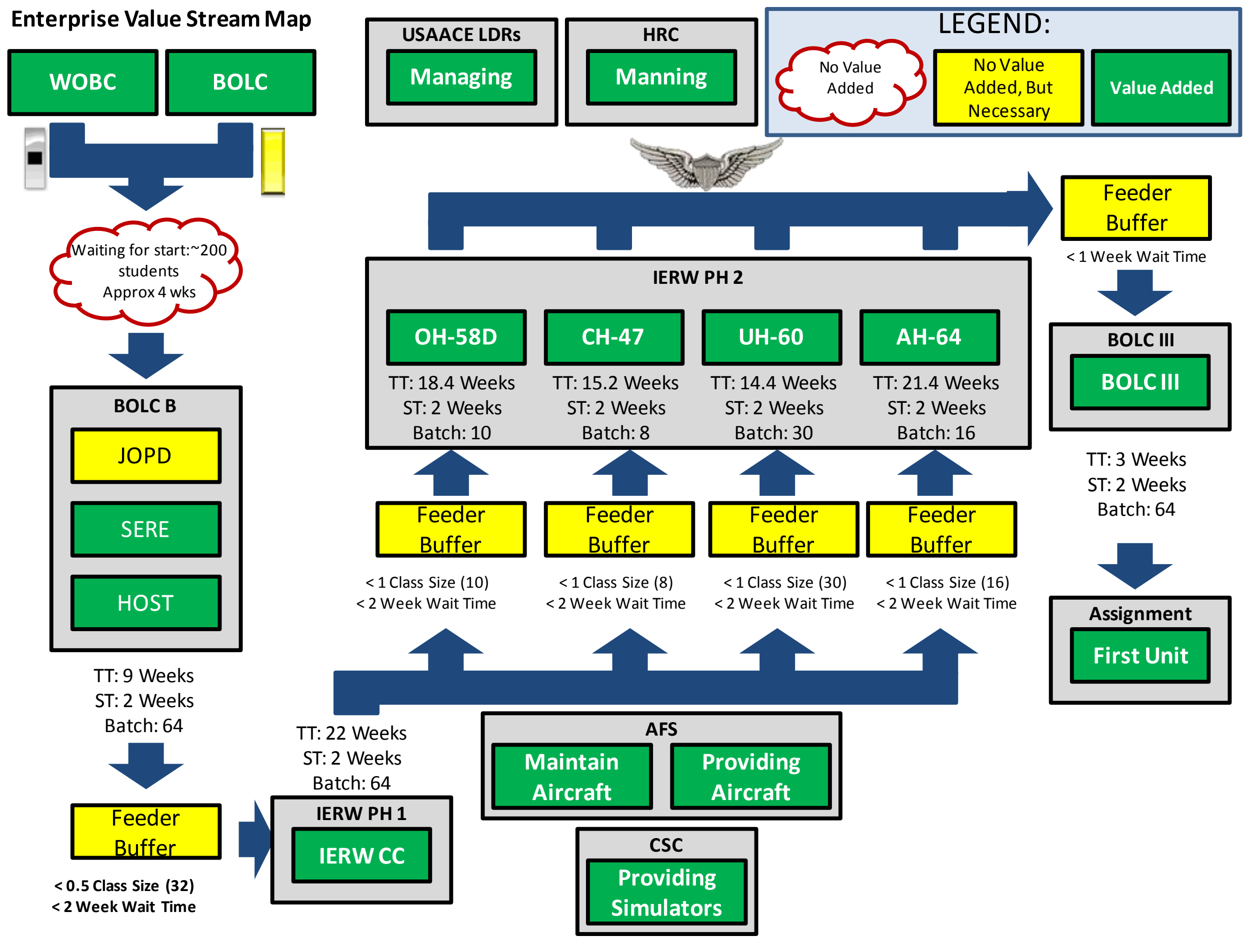

Figure 5-1: Future State Value Stream Map (Enos, et al. 2009)

In addition to establishing continuous flow, the future value stream map incorporates the recommended course lengths to account for weather days, which creates a robust process. Also, the future value stream map incorporates the BOLC III course back into the training program. The U.S. Army Aviation Center of Excellence (USAACE) recently cut the BOLC III course to reduce the throughput time for students. This course trained the students on how to plan and conduct combat operations as platoon leaders and members of a unit. Reincorporating the BOLC III course aligns with the Combat Aviation Brigade Battalion Commander's desire to have young aviators with better tactical knowledge on combined operations (Commanders 2010). Although the BOLC III course adds three weeks to the total throughput time, the reduction in the time spent in the various bubbles significantly shortens the total throughput time.

The only non-value added process that remains in the future value stream map is the bubble of students before the BOLC B process. The FS XXI Enterprise does not control the flow of students into the training process, so they are unable to directly affect the inflow of students into the process. The FS XXI Enterprise can minimize the impact of this bubble by maintaining the bubble before any of the training begins to ensure that wait times between courses does not degrade the aviator's skills. Although it is unlikely that the USAACE will be able to work with the Army's Human Resources Command to reduce the number of aviation lieutenants and warrant officers, they may be able to maintain the current inflow of 1200 students until they reduce this bubble by training 1498 students annually.

5.2: Future State Recommendations

Several recommendations for the FS XXI Enterprise will improve their current processes for training students. The Value Stream Map, Figure 5-1, provides the overall guide for the future state architecture and these recommendations will present specific actions to achieve the desire future state. The lean principles provided inspiration for and a method to organize these recommendations. First, the enterprise should align the number of students trained in advanced aircraft with the current aviation force structure. Although this recommendation does not exactly match the principle of pull, it at least provides the enterprise with an idea of the type and quantity of aviators required. Second, the principle of flow provides the inspiration for decreasing the batch size of students per class and eliminating the bubble of students in between the common course and the advanced aircraft courses. Also, the principle of flow guides the need to establish a stable process of training students. The final principle of pursue perfection drives the recommended metrics for the enterprise and recommendations to increase the knowledge of lean across the enterprise to continue to improve the process of training aviators (Womack and Jones 1996).

5.2.1: Customer Pull

The Army's Aviation Force Structure provides the demand for the type and quantity of aviators FS XXI produces. The current Active Duty force structure is composed of: four Heavy Combat Aviation Brigades (HCAB); six Medium CABs (MCAB); one Light CAB (LCAB); two Air Calvary Squadrons; and four theater support battalions. The National Guard is composed of two HCABs; six Expeditionary CABs (ECAB); one Air Calvary Squadron; and five theater support battalions. Table 5-1 presents the aviator demand for the active duty CABs and Table 5-2 presents the demand for National Guard aviators. Table 5-3 presents the total annual requirement for aviators by type of aircraft.

Active Army Units				
	AH-64	UH-60	CH-47	OH-58D
Heavy CABs				
1 HCAB	36	36	9	0
2 HCAB	36	36	9	0
3 HCAB	36	36	9	0
4 HCAB	36	36	9	0
Medium CABs				
1 MCAB	18	36	9	18
2 MCAB	18	36	9	18
3 MCAB	18	36	9	18
4 MCAB	18	36	9	18
5 MCAB	18	36	9	18
6 MCAB	18	36	9	18
Light CABs				
1 LCAB	0	36	9	36
Air Cav Squadrons				
1 CAV	18	6	0	0
2 CAV	0	6	0	18
MACOM/Theater Support				
1 GSB	0	12	6	0
1 TAB	0	23	9	18
2 GSB	0	15	0	0
3 GSB	0	6	0	0
TOTALS	270	464	114	180

Table 5-1: Aviator Demand for Active Duty Units (U.S. Army Aviation Warfighting Center 2008)

National Guard / Reserve Units				
	AH-64	UH-60	CH-47	OH-58D
Heavy CABs				
5 CAB	18	16	5	0
6 HCAB	18	16	5	0
Expeditionary CABs				
1 ECAB	9	16	5	9
2 ECAB	9	16	5	9
3 ECAB	9	16	5	9
4 ECAB	9	16	5	9
5 ECAB	9	16	5	9
6 ECAB	9	16	5	9
Air Cav Squadrons				
3 CAV	0	3	0	9
MACOM/Theater Support				
1 TA BN	0	8	6	0
2 TAB	0	16	10	0
3 TAB	0	34	6	0
4 TAB	0	12	14	0
5 TAB	0	34	6	0
TOTALS	90	235	82	63

Table 5-2: Aviator Demand for National Guard/Reserve Units (U.S. Army Aviation Warfighting Center 2008)

	AH-64	UH-60	CH-47	OH-58D	TOTAL
Totals Req	360	699	196	243	1498
Percentage	24%	47%	13%	16%	100%

Table 5-3: Total Aviator Demand by Aircraft (U.S. Army Aviation Warfighting Center 2008)

In a traditional lean production environment, the principle of customer pull works to create a process in which production does not begin until the company receives an order. In the FS XXI Enterprise, this would not work well because of the extremely long lead time to train an aviator. It is not likely that the Combat Aviation Brigades would request individual aviators to fill shortages. However, the aviation force structure provides an accurate demand forecast for the FS XXI Enterprise because of the stability of the force structure and the fixed timeline for officer and warrant officer promotions in the Army. So, the training process of the FS XXI Enterprise should meet the aviator demand provided by the aviation force structure.

5.2.2: Decreased Batch Size

The ultimate goal of a lean process would be to have single piece flow, or a batch size of one. However, this is not always possible because a lack of resource within the enterprise or constraints outside of the enterprise's control. These constraints prohibit the FS XXI Enterprise from achieving single piece flow. First, there are academic classes that accompany flight training which the enterprise currently conducts in large batches of students. It would not be an efficient use of resources to conduce these classes on an individual basis. Also, the current Program of Instruction (POI) specifies that one instructor pilot will train two students, so if the process were to change to a single piece flow the enterprise would need one instructor pilot for every student. Again, this is not an efficient use of resources. However, reducing the batch size from its current level could have potential benefits.

Reducing the batch size can reduce the number of resources required to produce the same quantity of students. This section focuses on the AH-64 Advanced Aircraft Course; however, the analysis could prove useful to the other Advanced Aircraft Course. The aviation force structure provided the demand for AH-64 of 360 aviators per year (U.S. Army Aviation Warfighting Center 2008). Based on the current POI, this would require a class size of 32 students beginning every four weeks (110th AB 2006). The analysis of reducing the batch size uses this as the current state of the enterprise. The future state of the enterprise specifics a class size of 16 students beginning every two weeks. Additionally, the future state POI incorporates five internal buffer days for weather and four days at the end of the course. The analysis considers these days as flight days and fully resources them with aircraft even though instructor pilots may not fly on these days if they do not need to conduct training. Figure 5-2 presents the aircraft utilization for the current state and the future state POIs.

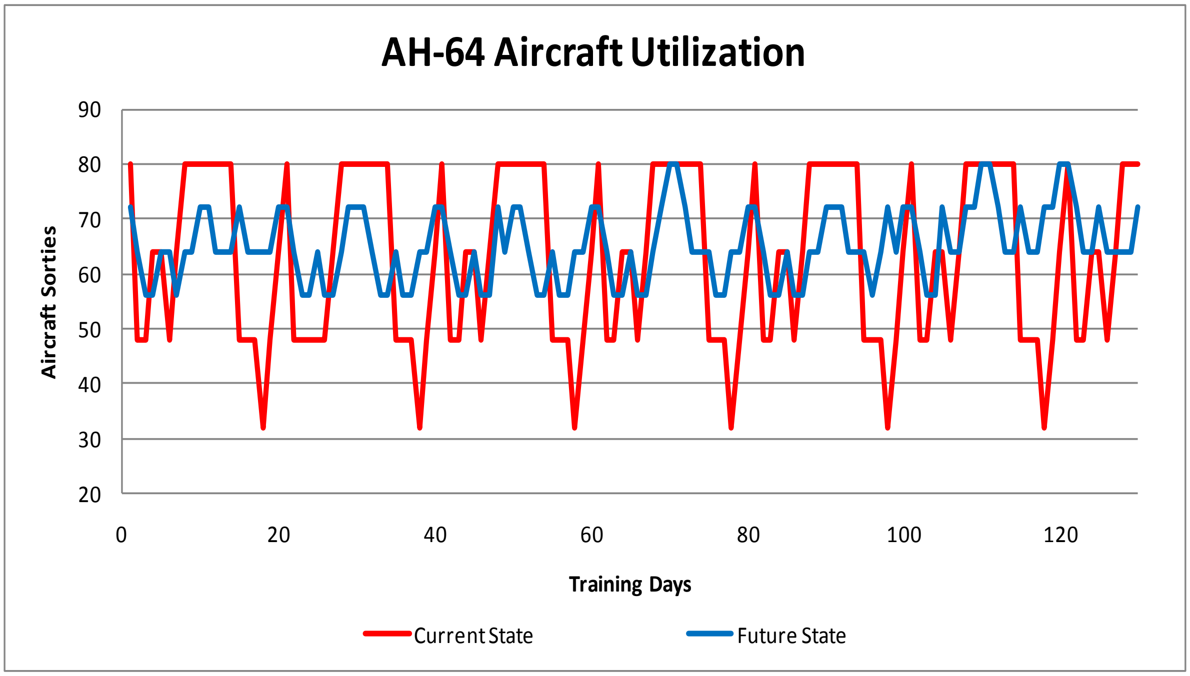

Figure 5-2: AH-64 Aircraft Utilization Comparison

In Figure 5-2, the red line represents the number of aircraft sorties required for training based on the current batch size of 32 students and the blue line represents the future state with a reduced batch size of 16. Appendix D contains a detailed future state POI per training day. Although both the current and future states peak at 80 aircraft sorties required, the current state has a larger volatility. This volatility creates an inefficient use of resources because several days require 80 sorties while other days only require 32. So, on several days dozens of aircraft remain idle. The future state, with a smaller batch size has considerably lower volatility. Generally, the required number of aircraft sorties range from 56 to 72 sorties and rarely peaks to 80. This is within the current number of aircraft sorties the contract requires the maintainers to provide of 85 sorties per day (AFS 2009).

Additionally, other courses compete with FS XXI for the aircraft supplied by Army Fleet Support (AFS). With the current batch size of 32, FS XXI utilized all but 5 sorties per day so the other courses can train a limited number of students. With the reduced batch size, FS XXI generally utilized a maximum of 72 sorties per day, which leaves 13 sorties for the other courses to utilize. This enables the other courses, instructor pilot course or maintenance test pilot course, to train additional students. However, FS XXI does require 80 sorties on a few days, so the USAACE would have to schedule other courses around these peak demand days. Also, of the six days FS XXI requires 80 aircraft sorties in the future state; three of these days are on buffer days, which may not require the full 80 aircraft. So, reducing the batch size of students in the Advanced Aircraft Course will increase the efficiency of resource utilization and could enable the enterprise to scale the number of students without additional aircraft.

5.2.3: Continuous Flow

Another goal of lean processes is to achieve continuous flow of the product through the production system. This means that once the product begins processing it the system continuously works on the product until completion. In the FS XXI Enterprise, continuous flow exists when the enterprise eliminates the bubble between the common course and the advanced aircraft course. To accomplish this task, a model of the bubble evaluated reducing the batch size as specified in the prior section and stopping three IERW Common Courses. The model compared these two courses of action with a base case which utilized the current POI. Table 5-4 through presents the planned capacity for the different courses of action as the enterprise transitions from the current capacity in the third and fourth quarter of FY 10. All course of action achieve an output of 1498 students from the Advanced Aircraft courses by the first quarter of FY 12 to meet the Army's requirements for the FS XXI Enterprise. In the Stop Classes course of action, the enterprise immediately cancels three IERW common core courses to reduce the number of students in the bubble awaiting the advanced aircraft courses. Although the enterprise cancels these courses, this does not interrupt the actual outflow of students from Ft. Rucker because the advanced aircraft courses output remains constant.

Current Plan											
Class Capacity	FY 10 Q3&4	FY 11 Q1&2	FY 11 Q3&4	FY 12 Q1&2	FY 12 Q3&4	Percentage IERW CC	FY 10 Q3&4	FY 11 Q1&2	FY 11 Q3&4	FY 12 Q1&2	FY 12 Q3&4
IERW CC	52	52	52	52	64						
UH-60	26	26	28	30	30	UH-60	0.52	0.50	0.50	0.46	0.46
CH-47	14	14	16	16	16	CH-47	0.14	0.14	0.14	0.14	0.14
OH-58D	12	14	16	20	20	OH-58D	0.12	0.14	0.14	0.16	0.16
AH-64	22	26	30	32	32	AH-64	0.22	0.22	0.22	0.24	0.24

Table 5-4: Course Capacity Plan for Current Plan

Smaller Batch Size											
Class Capacity	FY 10 Q3&4	FY 11 Q1&2	FY 11 Q3&4	FY 12 Q1&2	FY 12 Q3&4	Percentage IERW CC	FY 10 Q3&4	FY 11 Q1&2	FY 11 Q3&4	FY 12 Q1&2	FY 12 Q3&4
IERW CC	52	54	60	60	64						
UH-60	26	26	28	30	30	UH-60	0.52	0.50	0.50	0.48	0.47
CH-47	14	6	6	8	8	CH-47	0.14	0.14	0.13	0.12	0.13
OH-58D	12	6	8	10	10	OH-58D	0.12	0.14	0.13	0.14	0.15
AH-64	22	12	14	16	16	AH-64	0.22	0.22	0.24	0.26	0.25

Table 5-5: Course Capacity Plan for Smaller Batch Size

Stop Classes											
Class Capacity	FY 10 Q3&4	FY 11 Q1&2	FY 11 Q3&4	FY 12 Q1&2	FY 12 Q3&4	Percentage IERW CC	FY 10 Q3&4	FY 11 Q1&2	FY 11 Q3&4	FY 12 Q1&2	FY 12 Q3&4
IERW CC	52	54	60	60	64						
UH-60	26	28	28	30	30	UH-60	0.51	0.51	0.50	0.50	0.47
CH-47	14	6	8	8	8	CH-47	0.16	0.16	0.14	0.11	0.12
OH-58D	12	6	8	10	10	OH-58D	0.12	0.13	0.12	0.14	0.16
AH-64	22	12	14	16	16	AH-64	0.21	0.20	0.24	0.25	0.25

Table 5-6: Course Capacity Plan for Stop Classes

Figure 5-3 presents the Total Bubble results from this model. Although the enterprise initially increases the total bubble by stopping three common courses, this course of action reduces the bubble further than the other course of action. Also, by eliminating the bubble between the courses, the enterprise reduces the degradation of aviator skills caused by the long wait times.

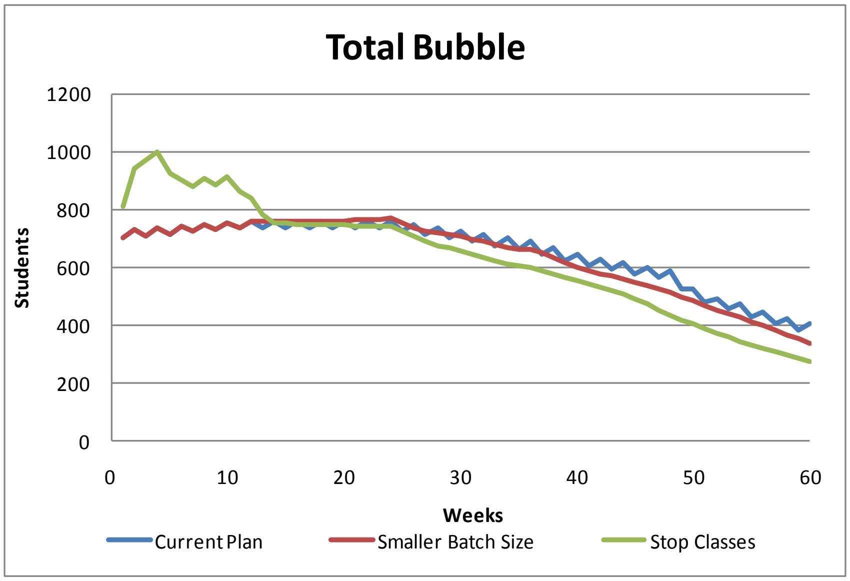

Figure 5-3: Bubble Model Results - Total Bubble

Figure 5-4 presents the advanced aircraft bubble results from the model. As the figure shows, the bubble remains the same for each of the course of action for several weeks because the effects of cancelling a common core course take 22 weeks to affect the system. The green line shows the effect of cancelling the three courses which results in a sharp decline of the bubble.

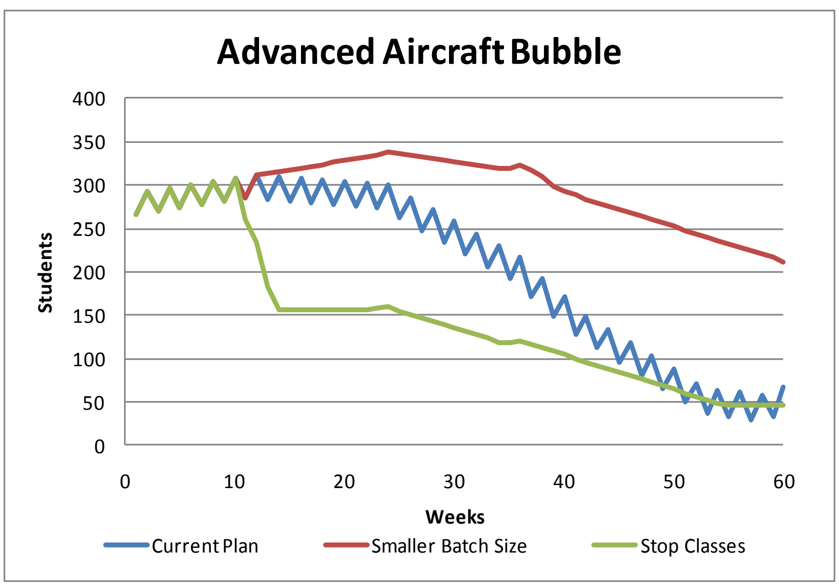

Figure 5-4: Bubble Model Results - Advanced Aircraft Bubble

Table 5-7 presents a comparison of the different course of action based on two criteria: amount of time wasted and the amount of time to reduce the bubble between the common and advanced courses to less than two classes. The amount of time wasted represents the amount of time that a student spends waiting in the bubble in person*weeks. The time to reduce the bubble to less than two classes represents the week in which the bubble is smaller than two class sizes. This ensures that students spend no more than 4 weeks in the bubble awaiting the advanced aircraft bubble. By stopping three IERW common courses, the enterprise can reduce the amount of time wasted by just over 2100 person*weeks despite the initial spike in the bubble during this course of action. Additionally, this course of action reduces the bubble to less than two classes by week 13 in FY 12. This is an improvement over simply reducing the batch size, which doesn't reduce the bubble to less than 2 class sizes and wastes an additional 600 person*weeks.

	Wasted Time (person*weeks)	Time to Bubble <2 Classes
Current Plan	78139	12-29
Smaller Batch Size	76614	N/A
Stop Classes	76034	12-13

Table 5-7: Bubble Model Course of Action Comparison

Also, by cancelling three IERW common courses, the enterprise frees resources which they could use to re-train aviators who have spent an excessive amount of time in the bubble on basic aviator skills. It might be difficult to conduct flight training in aircraft; however, the enterprise could create a refresher course in the simulators. Cancelling three courses frees approximately 150 instructor pilots and 5625 hours of simulator time. The FS XXI Enterprise could establish a refresher course to utilize these resources to retrain aviators who are about to enter an advanced aircraft course and have spent significant time in the bubble. This would reduce the amount of time instructor pilots in the advanced courses spent retraining basic aviator skills the students have forgotten.

5.2.4: Stable Process

Chapter 4 presented the analysis of the AH-64 Advanced Aircraft Course utilizing system dynamics to stabilize the course length. The system dynamics model demonstrated that at the current bubble level, the enterprise should add 10 additional buffer days to the POI to account for weather and increase the daily flight hour period to 3.5 hours per day from the current level of 3.0 hours per day. These two changes will increase the amount of time that instructor pilots have to make up training that weather cancelled or to conduct additional training for students who require additional flight time to master aviator tasks. Appendix D presents the recommended POI schedule by day with weather days.

The basis for recommending the addition of weather days stems from the fact that weather affects one day per week, plus or minus one day. The current POI has 15.8 weeks of flight training, so weather could affect between 0 and 31.6 days, with an average of 15.8 days per course. During an average course, one day of bad weather per week, good weather allows instructor pilots to train students 63.2 days, for 1.5 hours per day or 94.8 total flight hours. So, during an average course, instructor pilots are able to make up the training missed due to weather with an additional 5.4 flight hours for a buffer. This assumes that the student to instructor pilot ratio remains at 2 to 1 and allows for a full 1.5 hour flight window per day. However, the worst case scenario, in which two days per week are lost to weather, only allows instructor pilots to fly 71.1 hours. Instructor pilots would then require an additional 12.2 days to make up the 18.3 hour deficit to complete the required 89.4 hours specified by the POI. By adding 10 weather days as a buffer, the enterprise can negate the effects of weather on the course length.

The model found that in addition to the addition of weather days as a buffer, the increase of the daily flight hour period to 3.5 hours stabilized the course length. The 3.5 hour flight window enables instructor pilots to fly longer each day without adversely affecting the maintenance program. Aircraft require phase maintenance after every 750 flight hours. At the current maintenance level, the maintainers complete phase maintenance on two aircraft per week (AFS 2009). This constrains the instructor pilots to 1500 flight hours per week; otherwise, the maintenance system will develop a backlog of aircraft awaiting phase maintenance. The current contract states that Army Fleet Support will provide the USAACE with 85 sorties per day based on the current number of aircraft assigned (AFS 2009). If instructor pilots are able to fly all sorties, five days a week, there will be 425 sorties per week. Given the maintenance limits and current number of sorties per day, the maximum flight time per sortie is 1500/425 or 3.5 hours per sortie. The additional half-hour of flight time allows instructor pilots to make up for lost training time or assist students who are having difficulty with certain tasks if necessary.

5.2.5: Metrics and Alignment

The Enterprise Strategic Analysis and Transformation tool and X-Matrix identified several shortcomings in the metrics the enterprise currently utilizes. The following metrics provide the enterprise with better alignment between the objectives, metrics, processes, and stakeholder values.

Metric	Measurement	Process
Cumulative Student Throughput	Planned vs. actual student graduates	IERW CC & AA
Student Bubble (AA & CC)	# Students not in training	IERW CC & AA
Class Progression	Planned vs. actual course date	All Classes
Completed Tasks	Planned vs. actual tasks completed	IERW CC & AA
Available Aircraft for training	% aircraft delivered vs. requested	Maintenance
Available Simulators for training	% simulators delivered vs. requested	Simulators
Quality of Aviators Trained	Time to progress to RL-1	Feedback
Knowledge Center	Current Procedures Available	Knowledge
Qualified Instructor Pilots	% Qualified vs. assigned IPs	Execute PME

Table 5-8: Future State Metrics

Table 5-8 presents the proposed future state enterprise level metrics for the FS XXI Enterprise. These metrics align with the USAACE strategic objectives and measure FS XXI processes. The *Cumulative Student Throughput* metric measures the planned versus actual students that graduate from each course. This metric should measure the individual FS XXI courses as well as an overall throughput for the enterprise. The *Student Bubble* metrics measure the number of students who are not participating in training. These bubble metrics are the same as the current state and measure each of the individual bubbles. The *Class Progression* and *Completed Tasks* metrics measure the different training courses by tracking the planned versus actual course dates and the planned verses actual tasks completed. This provides the leadership with two measurements of progress. The *Available Aircraft for Training* metric measures the performance of the Army Fleet Support in providing instructor pilots with aircraft for training. This metric is the same as under the current state architecture. The *Available Simulators for Training* measures the performance of the Computer Science Corporation in providing simulators to the instructor pilots. The *Quality of Aviators Trained* metric measures the quality of the product the enterprise produces as viewed by the customer. A potential measurement for this metric could be the amount of time required to progress a new aviator to RL-1. When a new aviator arrives at a Combat Aviation Brigade, the CAB must train the new aviator through a process called the RL progression. The amount of time it takes an aviator to complete this process at the CAB is a result of the quality of training received during FS XXI. Because it is difficult to measure the "goodness" of an aviator, this measurement of the time for RL progression is a reasonable proxy for measuring quality. The *Knowledge Center* metric measures the number of current procedures available to the larger Aviation Enterprise in the knowledge repository. However, this metric should only measure current procedures and tactics, as non-current procedures and tactics do not provide value to the Aviation Enterprise. The *Qualified Instructor Pilots* metric measures the number of qualified instructor pilots versus assigned instructor pilots. At the FS XXI Enterprise level, this metric should combine several aspects of the Professional Military Education program, such as the instructor pilot course as well as warrant officer advanced course.

In addition to incorporating new metrics for the enterprise, the FS XXI Enterprise should adopt new processes in order to meet stakeholder values. The first recommended process is the Basic Officer Leadership Course III (BOLC III) training process, which the enterprise recently cancelled. This course provides collective training for new officers and warrant officers. Both the students and battalion commanders gain value from this training as it improves the quality of aviator produced and provides realistic training scenarios for the students. The next process the enterprise should adopt is a process to receive and incorporate feedback into training. The enterprise should survey battalion commanders or senior instructor pilots within the Combat Aviation Brigades (CABs) to determine the effectiveness of the FS XXI processes and any improvements they could make. The enterprise has begun to maintain an aviation knowledge center; however, the knowledge center could support the CABs training, synchronize the aviation enterprise's processes, and standardize the training effort. Finally, the enterprise should develop a process to execute the Professional Military Education to ensure members of the enterprise have the opportunity to attend professional development courses.

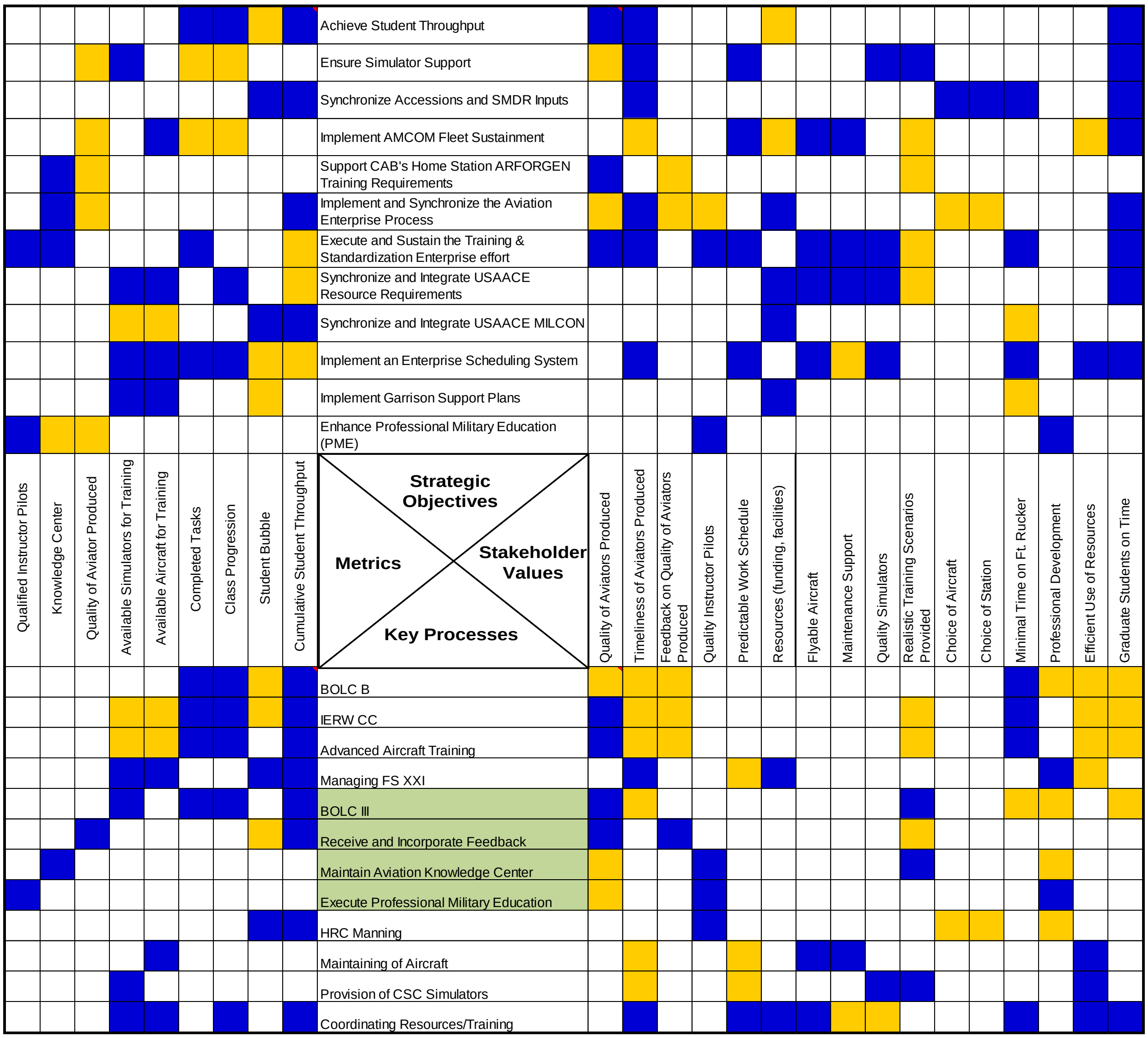

Figure 5-5: Future State X-Matrix

Figure 5-5 presents the future state X-Matrix with the recommended metrics and processes. The current state X-Matrix had several areas which did not align between the stakeholder values, objectives, metrics, and processes. The future state metrics all strongly align with at least one strategic objective, so that the enterprise has a measurement to support each of their objectives. This allows the enterprise to determine if they are meeting their strategic objectives through direct measurements. Also, in the future state X-Matrix, each of the processes has at least one metric that measures their performance. This enables the FS XXI Enterprise to measure each of their processes to determine how well the process is running and make decisions to adjust the process. Finally, with the additional processes, the enterprise processes strongly align with almost every stakeholder value. However, the student’s values of choice of aircraft and choice of duty station remain weakly aligned with the enterprise processes. This is acceptable as the needs of the Army outweigh the individual student’s choices of aircraft and duty station. Overall, the future state architecture appears to have better alignment than the current state.

5.2.6: Pursue Perfection

The principle of pursue perfection relates to the idea of continuous process improvement and that becoming truly lean is not an end state, but a continual process. In order to succeed at continuous improvement, the enterprise must invest in the workforce to gain a better understanding of lean thinking. Opportunities for professional development in lean thinking exist online through the Army’s eLearning program and members of the FS XXI Enterprise should be encouraged to participate in this free training. Also, several universities and consulting firms offer seminars in lean thinking or provide on-site service to teach lean techniques. The enterprise could use less formal educational methods as well to diffuse lean thinking; something as simple as having FS XXI staff members read books such as “Lean Thinking”, “Lean Enterprise Value”, or “Chasing the Rabbit”. All of these techniques educate the workforce in lean thinking and empower them to make recommendations to improve performance, which is essential to achieving perfection.

The other area in which there is a large opportunity for improvement is in processes at levels below the enterprise level, which are generally targets for lean improvements. With a holistic, enterprise level analysis of the FS XXI Enterprise this thesis provides, the enterprise can now focus on lower level processes that occur on a daily basis. The analysis conduct in this thesis identified several lower-level processes that could potentially benefit from lean principles. The enterprise could evaluate how they perform aircraft issue at the flight line as there are currently long wait times associated with this task. Also, this holds true for refueling operations during the flight window and time spent at the gunnery range. All of these inefficiencies subtract from the 3.5 hour flight window that instructor pilots have to train their students. So, any improvement in efficiency at these points, and potentially other points during the day could have a profound impact on the enterprise's performance. Although a detailed analysis of the current state is necessary, it is likely that the enterprise could benefit from smaller batch sizes on a daily basis. For example, if the enterprise broke the flight periods down even further to have two morning periods, two afternoon periods, and two night periods, the wait times at these various chokepoints could be reduced. With a workforce educated in lean, the FS XXI Enterprise could internally identify potential projects for continuous improvement.

5.3: Evaluation of Future State Architecture

The FS XXI Enterprise's future architecture should provide greater value robustness for its stakeholders than the current architecture. Four of the ilities provide evaluation criteria for the proposed future state architecture. The future state architected processes should be more robust, scalable, flexible, and adaptable to ensure value robustness for the FS XXI stakeholders. A probabilistic model of the AH-64 advanced aircraft course provides a method to evaluate the robustness of the future architecture. An evaluation of the resources needed to increase the throughput of the AH-64 advanced aircraft course provides a quantifiable evaluation of the scalability of the architecture. Finally, an analysis of the future architecture will determine the flexibility and adaptability architecture.

5.3.1: Robustness

Robustness is "the ability to remain constant in parameters in spite of system internal and external changes" (Ross, Rhodes and Hastings 2008). The FS XXI Enterprise must be able to produce the specified number of aviators regardless of the impact of weather or maintenance on the system. The system dynamics model Chapter 4 presented, evaluated several courses of action to stabilize the course length. However, the system dynamics model only simulates a single iteration of the course. With the number of weather days per week as a probability, a Monte-Carlo simulation of the course can evaluate the robustness of the new architecture.

The probabilistic course model simulated a single AH-64 course 1000 times to determine how often the course would run over schedule. The model incorporated a 20% chance of weather impacting training on scheduled flight days, which corresponds to the historical data that shows weather impacts training about one day a week (ACLC 2009). Also, the model completes all required training prior to moving to the next task. So, if weather impacted 1.2 hours of flight training the day before a simulator day was scheduled, the model would first complete the 1.2 hours of flight training and then progress to simulator training. Appendix D presents a portion of the model. The model tracks the simulated actual flight hours completed, cumulative hours flown, and any shortfalls in training.

The FS XXI Enterprise architecture is robust if weather does not impact the performance of the training process. Using the probabilistic course model of the current POI, the AH-64 course exceeded the scheduled course length 41% of the 1000 simulations. With the proposed future state POI, the AH-64 course only exceeded the scheduled course length 6 times during the 1000 iterations or 0.6% of the time. This is an outstanding improvement in the robustness of the process and shows how the addition of weather days and increasing the daily flight hour period will stabilize the course length.

5.3.2: Scalability

Ross, et al., defined scalability as “the ability to change the level of a parameter” (2008). The FS XXI Enterprise should be scalable in the number of students trained per course without the addition of additional aircraft. The resource utilization used to evaluate a smaller batch size can also determine how many students the enterprise can train given the current number of aircraft. The current number of aircraft allows the enterprise to conduct 85 AH-64 sorties per day; however, the AH-64 course must share these sorties with other courses that utilize the AH-64s.

The current state architecture allows the enterprise to train up to 34 AH-64 students per class with a maximum of 85 sorties per day. However, this architecture utilizes all 85 AH-64 sorties about 40% of the time, which does not provide many sorties for the other courses. The proposed future state architecture with the new POI enables the enterprise to train up to 17 AH-64 students per class. With the new architecture, the enterprise would only utilize 85 AH-64 sorties about 3% of the time, which leaves sorties for other courses. The enterprise would not be able to train 17 students per class because two students train together; however, the enterprise could alternate between 16 and 18 students per class. This would train 408 students per year with the 24 scheduled classes. So, the new architecture is more scalable than the current architecture because it can train the same number of students with fewer resources.

5.3.3: Flexibility / Adaptability

McManus, et al., defined flexibility as the "the ability of a system to be changed by a system-external change agent" (2007). In the FS XXI Enterprise, flexibility is the ability to change to meet new demands the Army places on the enterprise. For example, the Army has been attempting to acquire a new reconnaissance helicopter to replace the OH-58D Kiowa. If this occurs, the FS XXI Enterprise must change to train instructor pilots on the new aircraft, establish a Program of Instruction for the new reconnaissance helicopter, and transition classes from the Kiowa to the new helicopter. They must accomplish this while continuing to train aviators on the Kiowa and matching demand for aviators in the Combat Aviation Brigades.

It is difficult to conduct a quantitative analysis of the flexibility of the FS XXI Enterprise; however, a qualitative analysis of some attributes of the proposed future state architecture can determine if the future architecture is more flexible. First, the smaller batch size of students and classes that are more frequent lends itself to a faster change over and quicker reaction time. Under the current architecture, with four weeks separating classes, the enterprise would only be able to change the POI once a month. Whereas, with the new architecture, they could make changes to the POI twice a month and only affect half the number of students. Also, with the smaller batch size, the enterprise could switch between the Kiowa and the new reconnaissance helicopter depending on demand. So, if a Combat Aviation Brigade that had the new helicopter required aviators in June and another CAB required Kiowa pilots in July, the enterprise could change to meet the demands of the CABs as the Army transitions to the new reconnaissance helicopter. Also, the increased scalability of the future state architecture increases this flexibility, because it is possible to increase the number of students per class to meet the possible fluctuation in demand in this scenario without committing extra resources.

Adaptability is “the ability of a system to be changed by a system-internal change agent” (McManus, et al. 2007). The FS XXI Enterprise is adaptable if it can change to incorporate lessons learned into the POI from within the enterprise. For example, many of the instructor pilots are returning from Iraq and Afghanistan with new tactics and procedures that they used in combat. Also, as the enterprise pursues perfection, they will develop ideas to improve the efficiency and effectiveness of training aviators. So, the enterprise should be able to adapt to both how and what they train based on input from their employees. With the smaller batch size of students, it is easier for the enterprise to make minor changes to the POI and conduct a test with a smaller class. For example, if they decided to make a change to the AH-64 POI and test the change on a single class, under the new architecture, this would only affect 16 students. The enterprise could revert to the previous POI if the change did not have the desired effect and the impact would be smaller than under the current architecture where they would affect 32 students. Also, with the emphasis on increasing the knowledge on lean practices under the new architecture, the members of the Flight School XXI enterprise are empowered with the techniques necessary to improve performance on their own.

Overall, it appears that the proposed new architecture is both more flexible and adaptable than the current state architecture. The proposed architecture is able to meet the changing demands the Army places on the enterprise, such as the addition of a new aircraft to the fleet. Also, the future state places an emphasis on pursuing perfection and making continuous process improvement which enables the enterprise to adapt processes to be more effective and efficient.

5.4: Implementation Plan

The implementation plan is a process-centric plan to improve the FS XXI training processes to meet the strategic objectives. It consists of five phases that are two quarters in length and run from the 3rd quarter of FY 2010 until the end of FY 2012. The plan enables the FS XXI Enterprise to meet the Army's requirements of training 1498 students by FY 2012. The plan outlines the course capacity, schedule, and percentage of IERW common course gradates that will attend each advanced aircraft course. Additionally, this implementation plan follows the course of action Section 5.2.3 outlined that stops the common course for three classes to minimize the amount of time wasted by students.

Phase I (3rd & 4th QTR FY 10): The intent of Phase I is to set the conditions for future phases by cancelling two BOLC-B courses and three IERW Common Core Courses to reduce the bubble prior to the advanced aircraft courses. However, the class capacity for the courses remains the same. Table 5-9 presents the details of the course capacity, schedule, and percentage of the common course graduates to each advanced aircraft course. Also, this phase provides the opportunity for the enterprise to modify the POI to incorporate weather days into the schedule to stabilize the course length. Additionally, with the excess resources from cancelling the IERW Common Core course, the enterprise can begin a refresher training program for aviators who have spent a long time in the bubble and are about to begin an advanced aircraft course.

Course	Capacity	Schedule	% IERW Grads
BOLC-B	0 to 52	2 Weeks	
IERW CC	0 to 52	2 Weeks	
UH-60	26	2 Weeks	51%
CH-47	14	4 Weeks	16%
OH-58D	12	4 Weeks	12%
AH-64	22	4 Weeks	21%

Table 5-9: Implementation Plan – Phase I

Phase II (1st & 2nd QTR FY 11): Phase II incorporates the smaller batch size and more frequent class start dates to transition to a more lean process. In this phase, the FS XXI enterprise reduces the capacity for the CH-47, OH-58D, and AH-64 advanced aircraft courses by about half and begins these courses every two weeks. Table 5-10 presents the details for this phase of the implementation plan. Additionally, the percentage of the common core course graduates assigned to each advanced aircraft is an important aspect of the implementation plan because this ensures that each course has enough students to train at maximum capacity. Also, during this phase the effects of the changes in Phase I will begin to become apparent because of the delay between a class beginning under the new policy and the class completing 22 weeks later.

Course	Capacity	Schedule	% IERW Grads
BOLC-B	54	2 Weeks	
IERW CC	54	2 Weeks	
UH-60	28	2 Weeks	51%
CH-47	6	2 Weeks	16%
OH-58D	6	2 Weeks	13%
AH-64	12	2 Weeks	20%

Table 5-10 Implementation Plan – Phase II

Phase III (3rd & 4th QTR FY 11): During phase III, the enterprise increases the capacity of all of the courses to move towards the overall goal of training 1498 students. Table 5-11 presents the details for this phase of the plan. Again, the percentage of the common core course graduates that the enterprise assigns to each advanced aircraft is important to ensuring continuous flow and applies to any courses that graduate during this phase.

Course	Capacity	Schedule	% IERW Grads
BOLC-B	60	2 Weeks	
IERW CC	60	2 Weeks	
UH-60	28	2 Weeks	50%
CH-47	8	2 Weeks	14%
OH-58D	8	2 Weeks	12%
AH-64	14	2 Weeks	24%

Table 5-11: Implementation Plan – Phase III

Phase IV (1st & 2nd QTR FY 12): During this phase of the implementation plan, the enterprise begins to produce 1498 aviators per year to comply with the Army's requirement. Although the total capacity is not 1498 students, as the common core course remains at a capacity of 60 students per class, the actual output of the Flight School XXI enterprise will be 1498 because the advanced aircraft courses are at this capacity. Table 5-12 presents the details for Phase IV of the implementation plan including.

Course	Capacity	Schedule	% IERW Grads
BOLC-B	60	2 Weeks	
IERW CC	60	2 Weeks	
UH-60	30	2 Weeks	50%
CH-47	8	2 Weeks	11%
OH-58D	10	2 Weeks	14%
AH-64	16	2 Weeks	25%

Table 5-12: Implementation Plan – Phase IV

Phase V (3rd & 4th QTR FY 12): During Phase V, the enterprise reaches the steady state throughput for all of the classes and all courses operate at the 1498 annual student load. Table 5-13 presents the details of the steady state capacity, schedules, and percentage of common core course graduates to the advanced aircraft courses. Although this represents the completion of the implementation plan for the training process, it is not the completion of the lean transformation as the enterprise must continuously strive to improve the training process to increase the effectiveness and efficiency of aviator training.

Course	Capacity	Schedule	% IERW Grads
BOLC-B	64	2 Weeks	
IERW CC	64	2 Weeks	
UH-60	30	2 Weeks	47%
CH-47	8	2 Weeks	12%
OH-58D	10	2 Weeks	16%
AH-64	16	2 Weeks	25%

Table 5-13: Implementation Plan – Phase V

5.5: Impacts on Other Views

The Enterprise Architecture views do not exist in isolation and any changes to one view can have impacts on the other views. The future state architecture this thesis presents focuses on the strategy and process views of the enterprise; however, these recommendations will have impacts on other views. The changes to the process will impact the internal organization of the FS XXI Enterprise. Also, these changes will affect the manner in which the enterprise utilizes their information technology to schedule resources.

The largest impact on the other views will occur in the organization of the enterprise. As the class size decreases and the frequency of courses increases, the enterprise's organization will have to adapt to accommodate the increased number of classes. For example, the current organization for the AH-64 instructor pilots has six teams of instructor pilots, which aligns with the number of courses that they conduct simultaneously. Although the number of instructor pilots will not have to change, because the output is the same, the enterprise must re-organize these instructor pilots into thirteen teams of instructor pilots to accommodate the increase in the number of classes conducted simultaneously. This should remain true for both the OH-58D and CH-47 instructor pilots as well. The organization of the UH-60 instructor pilots should remain the same because the currently conduct classes every two weeks.

The recommended future state will also impact the information technology of the FS XXI Enterprise. Currently, the enterprise is implementing a resource scheduling program, Graduate Training and Integration Management System (GTIMS), which will aid in the scheduling of essential resources. This system will be essential for improving the process of requesting aircraft; however, the new Program of Instruction and class schedules will require the enterprise to update this system to account for these changes. Also, the enterprise may have to update their reporting procedures to account for the proposed metrics.

Also, to truly gain a holistic view of the FS XXI Enterprise, the enterprise should conduct a more detailed analysis of the enterprise utilizing the other views of the enterprise. This thesis addresses the main problem the enterprise is currently facing by improving the efficiency of the process of training students. However, additional benefits may become apparent to the enterprise as they examine the enterprise thorough the other Enterprise Architecture views.

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Chapter 6: Conclusion and Recommendations

This chapter presents the conclusions from the thesis, a summary of the recommendations to improve the performance of Flight School XXI (FS XXI) Enterprise, and potential areas for future work on this topic.

6.1: Conclusion

This thesis applied an eight view Enterprise Architecture reference framework, principles of lean thinking, and System Dynamics to the U.S. Army Aviation Center of Excellence's (USAACE) FS XXI Enterprise. These tools and methodologies provided a basis for recommendations to reduce the time students await training in order to reduce the overall cycle time for training aviators. The thesis identified the underlying causes of delays in training aviators that created the large bubble of students awaiting training. A System Dynamics model of the training process for the AH-64 advanced aircraft course provided valuable insights into the causes of these delays in training. The model identified weather and the student-to-instructor pilot ratio as two key causes of delays to the training course. The impact of these delays decreased the number of students that the enterprise could train and created the bubble of students awaiting training. The thesis then used these insights to determine how to stabilize the training process, develop a future state architecture, and prescribe an implementation plan to reduce the bubble of students and achieve the future state.

Chapter 2 provided a review of the current literature on Enterprise Architecture, lean thinking, and stakeholder theory. Chapter 3 utilized the Enterprise Strategic Analysis and Transformation tool to conduct an analysis of the current state of the enterprise and provided a basis to develop recommendations to improve the efficiency and effectiveness of the training process. Chapter 4 presented a review of the literature on System Dynamics as well as the model used to analyze the AH-64 advanced aircraft course. This chapter also provided a recommended course of action to stabilize the course length to ensure an uninterrupted flow of students through the FS XXI training processes. Finally, Chapter 5 described the vision for the future state and presented several recommendations for improving the effectiveness and efficiency of the training process.

6.2: Summary of Recommendations

This thesis presents four major recommendations to improve the effectiveness and efficiency of the FS XXI Enterprise's training processes. These recommendations include adopting a customer pull mentality to align production with demand from the Combat Aviation Brigades, decreasing the batch size for students in a class, establishing continuous flow of students by eliminating the bubble between the common core course and the advanced aircraft courses, and adding weather days to the Program of Instruction to stabilize the training process.

The concept of customer pull ensures that the enterprise will only produce the type and quantity of aviators needed by the Combat Aviation Brigades. The Aviation Force Structure provides the demand for aviators and the FS XXI Enterprise can align their training processes to this demand. The current force structure requires the enterprise to train 1498 total aviators per year broken down into 360 AH-64 pilots, 699 UH-60 pilots, 196 CH-47 pilots, and 243 OH-58D pilots. This demand provided the training requirement for the courses and determined the total capacity for each course.

By decreasing the batch size of students in the advanced aircraft courses, the enterprise can reduce the demand on critical resources. The enterprise can achieve continuous flow and utilize resources more efficiently by reducing the capacity of the advanced aircraft courses by 50% and beginning the classes every two week. This significantly reduced the number of aircraft required on a daily basis and reduced the volatility of the daily demand for aircraft. Also, by beginning all of the advanced aircraft courses every two weeks the enterprise eliminates the inherent wait time in the current value stream map as the common core course finishes every two weeks, but some advanced aircraft courses begin every four weeks.

By achieving continuous flow, the enterprise ensures that once a student begins the FS XXI process they do not stop training for more than two weeks. This decreases the impact that long wait time has on aviator skills which degrade over time. To accomplish this, the enterprise must first re-align the courses to ensure that the advanced aircraft courses begin every two weeks. Also, they must cancel three common core courses to reduce the current bubble between the common core course and the advanced aircraft courses. Chapter 5 outlines a five phase implementation plan for achieving continuous flow by fiscal year 2012. This plan also achieves the desired output of 1498 students by the Army's requirement of fiscal year 2012.

The final recommendation focuses on achieving a stable process for training aviators by adding weather days to the Program of Instruction (POI). The current POI accounts for weather with a longer daily flight period than necessary. This allows the instructor pilots to make up about 0.6 flight hours every day or about one day of training per week. However, the weather impacts one day, plus or minus one day per week on average. So, if the weather is average for a class, then the instructor pilots are able to complete the class on time given the current buffer. However, if weather affects 19.8 days or more, which is likely given the historical data, the instructor pilots are unable to complete training on time. The enterprise can alleviate the impact of weather by adding weather days to the POI. Additionally, the enterprise should extend the flight hour window from 3 hours per day to 3.5 hours per day, which is the maximum flight hour period possible given the current maintenance capabilities. A probabilistic model of the course with these changes indicated that the enterprise would complete the course on schedule 99.4% of the time, compared to 59% of the time without the additional weather days.

6.3: Future Work

The lean transformation effort is never complete and an enterprise should seek continuous improvement of their processes to ensure they remain a high performing organization. To that end, this section provides several areas for the enterprise to consider for future work and potential areas for continued academic research. The future work will enable the enterprise to sustain the recommended improvements and identify new areas for improvement.

6.3.1: Monitoring of Recommendations

An extremely important component of the recommendations this thesis proposed will be for the FS XXI Enterprise to monitor the outcomes of the recommendations. The enterprise should monitor the performance of the classes that the changes affect to ensure that the recommendations are resulting in the desired performance. After the enterprise modifies the Program of Instruction to add weather days to stabilize the process, they should closely monitor the course length of these classes to determine if the addition of weather days provides for a stable process. If this is not the case, they should determine the root cause of the course delays and make modifications to address the problem. Also, they should closely monitor the student bubble numbers to ensure that the proposed flow of students and canceling the common core course decreases the size of the bubble as predicted. Finally, the enterprise should monitor the resources utilized by the instructor pilot, aircraft and gunnery ranges, to ensure that a smaller batch size of students results in a more efficient use of these resources.

6.3.2: Enterprise Architecture Views

This thesis presented a very process centric architecture for the enterprise and the analysis focused on this view of the enterprise. However, the analysis of the enterprise through the other enterprise architecture views may provide valuable insights into the FS XXI Enterprise. The organization view could determine the appropriateness of the current organization for the FS XXI Enterprise and gains in efficiency could come from reorganizing the instructor pilots, maintenance providers, and students. Also, the information technology view could identify potential shortcomings in the new resource planning tool that the enterprise recently adopted and provide recommendations for improvements to the system that will increase the effectiveness of the enterprise's interactions.

6.3.3: Enterprise Measurement System

The FS XXI Enterprise would benefit from a detailed analysis of the current enterprise measurement system. The metrics Chapter 5 recommended provide an improved set of metrics that align with the strategic objectives and the key enterprise level processes. However, the enterprise could improve their measurement system to ensure that all of the metrics are measurable and drive the leadership's decision making process. Also, the enterprise may benefit from adopting several leading indicators to determine the direction of the enterprise before the impacts of negative trends are irreversible. One possible leading indicator is the measurement of the number of weather days utilized by the instructor pilots and comparing that to the number of flight hours remaining for the course. Through this metric, the enterprise would be able to determine if the instructor pilots will be able to complete the course on time and could take action to ensure they complete the class on time.

6.3.4: Expansion of Lean Thinking

The enterprise could expand the use of lean principles beyond the enterprise level training process to sub-processes that will affect the overall performance of the enterprise. The maintenance providers have already adopted lean thinking with a great deal of success and continue to improve their internal processes. Now, the FS XXI Enterprise could expand lean thinking to other areas of the training process. They could apply lean principles to their daily operations to improve the efficiency of the time spent at the flight line. Potential improvements include reducing time to issue aircraft, reducing wait times at re-fueling positions, reducing wait time at the gunnery ranges, and more efficient use of stage fields and training areas. Also, as lean thinking permeates through the enterprise the instructor pilots and staff will identify additional areas for improvement. The USAACE Leadership should embrace these recommended improvements and allow the enterprise members to test their ideas before the enterprise adopts them across the enterprise.

6.3.5: Academic Research

This thesis identified two potential areas for future academic research to expand the use of the Enterprise Architecture reference framework. First, researchers could further explore the direct link between the Policy / External Factors view and the Process view that exists in the FS XXI Enterprise. In this enterprise, weather, an external factor, directly impacts the process of training students. Further academic research could determine if this link exists in other enterprises or is a phenomenon that is limited to military training enterprises. Also, researchers could expand the use of System Dynamics to model other views of the enterprise.

System Dynamics often models the process or strategic views of the enterprise; however, one could utilize System Dynamics to model other views, such as the knowledge view. This progresses both the literature on Enterprise Architecture as well as the literature on System Dynamics.

References

110th AB. "AH-64D Longbow POI." Ft. Rucker, AL: U.S. Army Aviation Center of Excellence, September 2006.

110th Aviation Brigade. "Status of Flight Line Report." Ft. Rucker, AL: U.S. Army Aviation Center of Excellence, 2009.

1-14 Avaition Regiment. "1-14th Crew Endurance Policy." *1-14th Aviation Regiment SOP*, April 2008: 37-39.

1st Aviation Brigade. "Awating Training Report." Ft. Rucker, AL: U.S. Army Aviation Center of Excellence, September 25, 2009.

ACLC. "Annual Aircraft Utilization." Ft. Rucker, AL: U.S. Army Aviation Center of Excellence, 2009.

AFS, interview by James Enos. "Coordinator, Army Fleet Support." *ACLC / AFS Survey.* Ft. Rucker, AL, (October 20, 2009).

Allen, Thomas, Deborah Nightingale, and Earl Murman. "Engineering Systems: An Enterprise Perspective." Cambridge, MA: MIT Engineering Systems Division, March 31, 2004.

ATRRS. *Army Training Requirements and Resource System Course Catalog.* U.S. Army. January 22, 2010. https://atrrs.army.mil/atrrscc/course.aspx (accessed February 15, 2010).

Barclay, James MG. "The Big Opprotunity." Ft. Rucker, AL: U.S. Army, October 20, 2009.

Black's Law Dictionary. *Black's Law Dictionary.* 9th Edition. Edited by Brian Garner. St. Paul, MN: West Group, 2009.

Commanders, Battalion, interview by James Enos. *Flight School XXI Battalion Commander Survey* 10 Surveys Completed, (January 20, 2010).

CSC, interview by James Enos. "Director, Computer Science Corporation." *ACLC / AFS Survey.* Cambridge, MA, (October 6, 2009).

Dinges, John LTC. "Army Aviation Training Program: Interim Analysis Review Board." Washington DC: Center For Army Analysis, May 21, 2009.

Enos, James, John Hess, Greg McNew, and Jed Richards. *ESD.61 Report: U.S. Army Aviation Center of Excellence.* Cambridge, MA: Massachusetts Insitute of Technology, 2009.

Forrester, Jay W. *Industrial Dynamics.* Waltham, MA: Pegasus Communications Inc, 1961.

—. *Principles of Systems.* Cambridge, MA: Wright-Allen Press, Inc., 1968.

—. *World Dynamics.* Cambridge, MA: Wright-Allen Press, INC, 1971.

Freeman, R. Edward. *Strategic Management: A Stakeholder Approach.* Boston, MA: Pitman, 1984.

Freeman, R. Edward, Jeffrey Harrison, and Andrew Wicks. *Managing for Stakeholders: Survival, Reputation, and Success.* New Haven, CT: Yale University Press, 2007.

Friedman, Andrew, and Samantha Miles. *Stakeholders: Theory and Practice.* New York, NY: Oxford University Press, 2006.

Frooman, Jeff. "Stakeholder Influence Strategies." *Academy of Management Review* (Academy of Management) 24, no. 2 (April 1999): 191-205.

FSXXI, Team, interview by James Enos. *Flight School XXI Team Survey* 2 Surveys Completed, (January 20, 2010).

Gates, Robert. "Secretary of Defense Comments at USAACE." Ft. Rucker, AL, April 9, 2008.

Goldratt, Eliyahu. *The Goal.* Great Barrington, MA: North River Press, 1984.

Grossi, Ignacio. *Stakeholder Analysis in the Context of the Lean Enterprise.* Cambridge, MA: Massachusetts Institue of Technology, 2003.

Leadership, USAACE, interview by James Enos. *ESAT Interaction Evaluation* Ft. Rucker, AL: 19 Interviews, (October 2009).

Leadership, USAACE, interview by James Enos. *Flight School XXI Leadership Survey* 3 Surveys Completed, (January 20, 2010).

Lyneis, James. "System Dynamics for Business Strategy: A Phased Approach." *System Dynamics Review* 15, no. 1 (Spring 1999): 37-70.

Lyneis, James, and David Ford. "System Dynamics Applied to Project Management: A Survey, Assessment, and Directions for Future Research." *System Dynamics Review* 23, no. 2/3 (Summer/Fall 2007): 157-189.

Lyneis, James, Kenneth Cooper, and Sharon Els. "Strategic Management of Complex Projects: A Case Study Using System Dynamics." *System Dynamics Review* 17, no. 3 (Fall 2001): 237-260.

Maier, Mark, and Eberhardt Rechtin. *The Art of Systems Architecting.* Second Edition. New York, NY: CRC Press, 2002.

McManus, Hugh, Matthew Richards, Adam Ross, and Daniel Hastings. "A Framework for Incorporating “ilities” in Tradespace." *American Institute of Aeronautics and Astronautics 2007.* Long Beach, CA, 2007.

Meadows, Donella, Jorgen Randers, and Dennis Meadows. *Limits to Growth: The 30-year Update.* White River Junction, VT: Chelsea Green Publishing Company, 2004.

Mitchell, Ronald, Bradley Agle, and Donna Wood. "Toward a Theory of Stakeholder Identification and Salience: Defining the Principle of Who." *The Academy of Management Review* (Academy of Management) 22, no. 4 (October 1997): 853-886.

Murman, Earll, et al. *Lean Enterprise Value: Insights from MIT's Lean Aerospace Initiative.* New York, NY: Palgrave, 2002.

Nightingale, Deborah. "Principles of Enterprise Systems." *Second International Symposium on Engineering Systems.* Cambridge, MA: MIT, 2009.

Nightingale, Deborah, Alexis Stanke, and F. Terry Bryan. "Enterprise Strategic Analysis and Transformation Guide." Vol. 2.0. Cambridge, MA: MIT Lean Advancement Initiative, September 2008.

Nightingale, Deborah, and Donna Rhodes. "Enterprise Systems Architecting: Emerging Art and Science within Engineering Systems." *MIT Engineering Systems Symposium.* Cambridge, MA: Massachussetts Institute of Technology, 2004.

—. "ESD.38J Enterprise Architecture." *Course Notes.* Cambridge, MA: Massachuessetts Institute of Technology, 2007.

Pilots, Instructor, interview by James Enos. *Flight School XXI Instructor Pilot Survey* 27 Surveys Completed, (January 20, 2010).

Representative, Aviation Branch, interview by Jed Richards. *Flight School XXI Human Resources Command Survey* (October 5, 2009).

Rhodes, Donna, Adam Ross, and Deborah Nightingale. "Architecting the System of Systems Enterprise: Enabling Constructs and Methods from the Field of Engineering Systems." *SysCon2009 – IEEE International Systems Conference.* Vancouver, Canada: IEEE, 2009.

Richardson, George P. *Feedback Thought in Social Sciences and Systems Theory.* Pennsylvania , PA: University of Pennsylvania Press, 1991.

Ross, Adam, and Donna Rhodes. "Architecting Systems for Value Robustness: Research Motivations and Progress." *IEEE International Systems Conference.* Montreal, Canada, 2008.

Ross, Adam, Donna Rhodes, and Daniel Hastings. "Defining Changeability: Reconciling Flexibility, Adaptability, Scalability, Modifiability, and Robustness for Maintaining System Lifecycle Value." *Systems Engineering* (Wiley Periodicals, Inc), 2008.

Rouse, William. "Enterprises as Systems: Essential Challenges and Approaches to Transformation." Atlanta, GA: Georgia Institute of Technology, February 12, 2005.

Sterman, John. *Business Dynamics: Systems Thinking and Modeling for a Complex World.* Boston, MA: Irwin McGraw-Hill, 2000.

Students, interview by James Enos. *Flight School XXI Student Survey* 13 Surveys Completed, (January 20, 2010).

U.S. Army Aviation Warfighting Center. "Aviation Force Structure 2008." Ft. Rucker, AL: U.S. Army, January 15, 2008.

USAACE. "Flight School XXI Increase." Ft. Rucker, AL: U.S. Army, March 1, 2008.

—. "FY 10 Flight School XXI." Ft. Rucker, AL: U.S. Army, October 21, 2009.

—. "USAACE Top 6." Ft. Rucker, AL: U.S. Army, October 27, 2009.

—. "Whitebook FY10." Ft. Rucker, AL: U.S. Army Aviation Center of Excellence, 2009.

Womack, James, and Daniel Jones. *Lean Thinking: Banish Waste and Create Wealth in Your Corporation.* New York, NY: Free Press, 1996.

Womack, James, Daniel Jones, and Daniel Roos. *The Machine That Changed The World.* New York, NY: Macmillian Publishing Company, 1990.

Appendix A: Flight School XXI Data

A-1: Flight School Metrics

Total	Course Adherenc to Schedule (Average)	Training Schedule Varriance (Total)	Start Deviation (Maximum)	Number of Studens (Total)	Annual Planned Load
Date	Days (+/-)	Hour (+/-)	Days (+/-)	Students	Students
13-Apr-09	46	5854	0	1075	2400
27-Apr-09	35	4012	0	1085	2400
15-May-09	19	1503	71	992	2400
1-Jun-09	25	3171	71	1066	2400
15-Jun-09	31	2735	71	1040	2400
1-Jul-09	13	1213	71	1066	2400
15-Jul-09	22	2470	71	1033	2400
31-Jul-09	28	2850	0	1033	2400
17-Aug-09	25	3011	24	1062	2400
2-Sep-09	26	3234	24	1044	2400
14-Sep-09	21	3119	24	1061	2400
5-Oct-09	12	1546	9	1054	2400
Trend	(-)	(-)	(-)	(=)	(=)

IERW	Course Adherenc to Schedule (Average)	Training Schedule Varriance (Total)	Start Deviation (Maximum)	Number of Studens (Total)	Annual Planned Load
Date	Days (+/-)	Hour (+/-)	Days (+/-)	Students	Students
13-Apr-09	0	-141	NR	501	1200
27-Apr-09	0	246	NR	503	1200
15-May-09	1	364	NR	500	1200
1-Jun-09	0	-163	NR	503	1200
15-Jun-09	0	145	NR	474	1200
1-Jul-09	1	501	NR	507	1200
15-Jul-09	0	-153	NR	513	1200
31-Jul-09	-1	-253	NR	508	1200
17-Aug-09	0	37	NR	513	1200
2-Sep-09	-1	-496	NR	523	1200
14-Sep-09	0	-308	NR	522	1200
5-Oct-09	-2	9	NR	517	1200
Trend	(=)	(-)		(=)	(=)

AH-64	Course Adherenc to Schedule (Average)	Training Schedule Varriance (Total)	Start Deviation (Maximum)	Number of Studens (Total)	Annual Planned Load
Date	Days (+/-)	Hour (+/-)	Days (+/-)	Students	Students
13-Apr-09	-30	-4261	NR	174	264
27-Apr-09	-23	-3382	NR	182	264
15-May-09	-5	-1093	71	159	264
1-Jun-09	-6	-1883	71	212	264
15-Jun-09	-9	-1878	71	190	264
1-Jul-09	-5	-1289	71	192	264
15-Jul-09	-8	-1793	71	175	264
31-Jul-09	-9	-1459	-4	147	264
17-Aug-09	-9	-1716	24	151	264
2-Sep-09	-11	-1764	24	130	264
14-Sep-09	-9	-2056	24	150	264
5-Oct-09	-4	-1385	9	168	264
Trend	(-)	(-)	(-)	(-)	(=)

OH-58D	Course Adherenc to Schedule (Average)	Training Schedule Varriance (Total)	Start Deviation (Maximum)	Number of Studens (Total)	Annual Planned Load
Date	Days (+/-)	Hour (+/-)	Days (+/-)	Students	Students
13-Apr-09	-6	-515	NR	60	144
27-Apr-09	-6	-334	NR	53	144
15-May-09	-4	-260	0	49	144
1-Jun-09	-6	-324	0	44	144
15-Jun-09	-4	-278	0	61	144
1-Jul-09	0	-28	0	66	144
15-Jul-09	-1	-74	0	61	144
31-Jul-09	-2	-144	0	56	144
17-Aug-09	-1	-104	0	57	144
2-Sep-09	-1	-89	24	56	144
14-Sep-09	-1	-46	-76	62	144
5-Oct-09	-1	-148	0	55	144
Trend	(=)	(+)	(-)	(+)	(=)

UH-60	Course Adherenc to Schedule (Average)	Training Schedule Varriance (Total)	Start Deviation (Maximum)	Number of Studens (Total)	Annual Planned Load
Date	Days (+/-)	Hour (+/-)	Days (+/-)	Students	Students
13-Apr-09	-1	-288	NR	257	624
27-Apr-09	0	35	NR	243	624
15-May-09	0	108	NR	202	624
1-Jun-09	0	-67	NR	234	624
15-Jun-09	0	1	NR	238	624
1-Jul-09	1	187	NR	227	624
15-Jul-09	0	-31	NR	222	624
31-Jul-09	-1	-225	NR	249	624
17-Aug-09	-2	-586	NR	270	624
2-Sep-09	-1	-206	NR	274	624
14-Sep-09	-1	-166	NR	261	624
5-Oct-09	0	-30	NR	265	624
Trend	(=)	(-)		(=)	(=)

CH-47	Course Adherenc to Schedule (Average)	Training Schedule Varriance (Total)	Start Deviation (Maximum)	Number of Studens (Total)	Annual Planned Load
Date	Days (+/-)	Hour (+/-)	Days (+/-)	Students	Students
13-Apr-09	-9	-649	NR	83	168
27-Apr-09	-6	-577	NR	104	168
15-May-09	-11	-622	NR	82	168
1-Jun-09	-13	-734	NR	73	168
15-Jun-09	-18	-725	NR	77	168
1-Jul-09	-10	-584	NR	74	168
15-Jul-09	-13	-419	NR	62	168
31-Jul-09	-15	-769	NR	73	168
17-Aug-09	-13	-642	NR	71	168
2-Sep-09	-12	-679	NR	61	168
14-Sep-09	-10	-543	NR	66	168
5-Oct-09	-5	8	NR	49	168
Trend	(-)	(-)		(-)	(=)

A-2: Bubble Data

	BOLC IIIA	IERW CC	AH-64	CH-47	OH-58D	UH-60	Total PH 2	BOLC IIIB	Total
18-Oct-07	185	126	45	25	20	128	218	4	533
1-Nov-07	103	88	59	30	29	97	215	10	416
15-Nov-07	209	68	52	28	21	107	208	21	506
29-Nov-07	173	60	66	33	31	97	227	32	492
13-Dec-07	327	101	58	27	29	91	205	12	645
10-Jan-08	266	54	66	16	34	106	222	1	543
31-Jan-08	300	95	78	23	31	97	229	2	626
14-Feb-08	229	108	95	39	44	115	293	9	639
28-Feb-08	252	100	80	30	36	94	240	12	604
13-Mar-08	267	100	48	34	45	91	218	1	586
27-Mar-08	243	107	92	27	39	87	245	5	600
10-Apr-08	263	109	95	33	40	105	273	3	648
24-Apr-08	259	121	82	22	37	114	255	0	635
8-May-08	233	133	85	9	31	128	253	16	635
22-May-08	233	133	85	9	31	128	253	16	635
5-Jun-08	321	142	103	12	39	127	281	1	745
19-Jun-08	306	153	99	3	36	120	258	18	735
2-Jul-08	200	167	90	12	37	129	268	12	647
17-Jul-08	234	163	73	1	27	110	211	11	619
31-Jul-08	193	177	85	23	33	113	254	30	654
14-Aug-08	168	171	84	20	31	108	243	11	593
28-Aug-08	152	224	106	19	41	107	273	39	688
11-Sep-08	242	184	118	23	47	137	325	47	798
25-Sep-08	151	251	113	24	42	117	296	28	726
8-Oct-08	153	209	95	21	44	109	269	23	654
23-Oct-08	174	259	105	24	55	129	313	28	774
5-Nov-08	150	247	119	34	60	127	340	15	752
19-Nov-08	174	290	106	24	55	127	312	1	777
3-Dec-08	285	297	119	26	60	136	341	3	926
17-Dec-08	344	214	107	18	56	161	342	10	910
31-Dec-08	344	214	107	18	56	161	342	10	910
14-Jan-09	272	166	107	19	56	115	297	8	743
28-Jan-09	258	136	119	14	54	144	331	9	734
10-Feb-09	244	201	117	13	54	140	324	18	787
25-Feb-09	206	191	127	16	58	138	339	30	766
10-Mar-09	241	213	116	25	67	168	376	16	846
25-Mar-09	208	197	116	10	60	151	337	6	748
10-Apr-09	206	211	116	8	55	125	304	3	724
24-Apr-09	182	209	108	2	56	130	296	5	692
8-May-09	230	199	95	4	53	131	283	5	717
22-May-09	260	148	96	10	46	136	288	3	699
5-Jun-09	282	122	83	10	49	126	268	3	675
19-Jun-09	278	144	91	7	54	146	298	3	723
3-Jul-09	350	97	97	12	57	151	317	4	768
17-Jul-09	263	54	74	5	55	153	287	54	658
31-Jul-09	403	7	83	9	49	148	289	1	700
14-Aug-09	413	78	77	10	58	147	292	1	784
28-Aug-09	389	10	88	14	56	142	300	1	700
11-Sep-09	389	10	88	14	56	142	300	1	700
25-Sep-09	375	76	101	17	59	137	314	0	765

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Appendix B: Survey Information and Results

B-1: COUHES Exemption Form

MIT Committee On the Use of Humans as Experimental Subjects

MASSACHUSETTS INSTITUTE OF TECHNOLOGY
77 Massachusetts Avenue
Cambridge, Massachusetts 02139
Building E 25-143B
(617) 253-6787

To:	James Enos
From:	Leigh Firn, Chair COUHES
Date:	06/23/2009
Committee Action:	**Exemption Granted**
Committee Action Date:	06/23/2009
COUHES Protocol #:	0906003308
Study Title:	Re-Architecting Flight School XXI: An Application of Enterprise Architecture

The above-referenced protocol is considered exempt after review by the Committee on the Use of Humans as Experimental Subjects pursuant to Federal regulations, 45 CFR Part 46.101(b)(2) .

This part of the federal regulations requires that the information be recorded by investigators in such a manner that subjects cannot be identified, directly or through identifiers linked to the subjects. It is necessary that the information obtained not be such that if disclosed outside the research, it could reasonably place the subjects at risk of criminal or civil liability, or be damaging to the subjects' financial standing, employability, or reputation.

If the research involves collaboration with another institution then the research cannot commence until COUHES receives written notification of approval from the collaborating institution's IRB.

If there are any changes to the protocol that significantly or substantially impact the rights of human subjects you must notify the Committee before those changes are initiated.

You should retain a copy of this letter for your records.

B-2: Sample Survey

1. What type of Aircraft do you fly? (AH-64, UH-60, CH-47, OH-58D)

		Scale of 1 to 5 (1=low, 5 = high)	
		How important is this?	How well does the USAACE deliver this?
2.	What aspects of Flight School XXI do you value?		
	Quality of Aviator Produced		
	Timeliness of Aviators Produced		
3.	What do you expect from your involvement with Flight School XXI?		
4.	What things would make you think highly of Flight School XXI?		
5.	What do you feel you **do** contribute to Flight School XXI?		
6.	What do you feel you **could** contribute to Flight School XXI?		

For questions 7 – 8, rank the views from 7 (high) to 1 (low), each number can only be used once per question.							
7. How important are the following aspects of Flight School XXI?	1	2	3	4	5	6	7
- Strategy: Unit Mission and Commander's Intent							
- Policy: Army Regulations governing flight training							
- Process: Current Program of Instruction (POI)							
- Product: Quality Aviator							
- Information: Accurate, timely status of training, resources, and course progression.							
- Knowledge: Sharing of lessons learned and techniques for training students.							
- Organization: Task organization of the USAACE							

8. How much influence do you feel you have on the following aspects of Flight School XXI?	1	2	3	4	5	6	7
- Strategy: Unit Mission and Commander's Intent							
- Policy: Army Regulations governing flight training							
- Process: Current Program of Instruction (POI)							
- Product: Quality Aviator							
- Information: Accurate, timely status of training, resources, and course progression.							
- Knowledge: Sharing of lessons learned and techniques for training students.							
- Organization: Task organization of the USAACE							

9. How effective is the current POI in training new pilots? Are the current flight hours as dictated by the POI adequate for training tasks?

10. Is the current "bubble" degrading pilot skills between IERW CC and IERW Phase II?

11. How much training time spent re-learning basic aviator skills? How does this affect training prescribed by the POI?

12. How closely do you follow the flight hours specified in the POI when training new pilots? The tasks to be trained by day?

13. How often does weather effect training?

14. What improvements could be made to the current POI to improve effectiveness and efficiency?

15. What resource constraints limit training opportunities?

16. What are the motivations to complete training according to the POI? If there are none, what would motivate you to complete training according to the POI?

17. Would additional training days set aside for "IP selected" training be effective? If additional days for training were set aside, would you be more likely to follow the training outlined in the POI?

18. What cultural barriers exist to changes within the USAACE? How can these be overcome?

19. Any additional comments?

B-3: Survey Results

CAB Battalion Commanders (Commanders 2010)***:***

1. What is the Primary Aircraft in your battalion?	**AH-64**	**OH-58D**	**CH-47**	**UH-60**
	1	1	4	5

2. What Aspects of FS XXI do you Value?										
	How Important is this?					How Well does the Enterprise accomplish this?				
	Very				Not Very	Very Well				Not Well
	5	4	3	2	1	5	4	3	2	1
Quality of Aviatior Produced	8	2				3	5	2		
Timeliness of Aviatior Produced	6	3	1			2	2	2	4	

3. Enterprise Architecture Views										
	How Important is this?					How much influence do you feel you have on this?				
	Very				Not Very	A lot				Not Much
	5	4	3	2	1	5	4	3	2	1
Strategy	2	2	4	2	0	0	0	2	4	4
Policy	5	4	1	0	0	0	0	3	5	2
Process	3	7	0	0	0	0	0	5	5	0
Product	9	1	0	0	0	0	0	3	7	0
Information	3	6	1	0	0	0	0	2	6	2
Knowledge	3	5	2	0	0	2	1	3	4	0
Organization	0	1	7	2	0	0	0	0	5	5

Please Rate the Following	Strongly Agree				Strognly Disagree
	5	4	3	2	1
Under Flight School XXI new pilots are better trained	3	4	2	1	0
It requires less time to get a pilot trainied under FS XXI to RL 1 than it did with pilots trained under the legacy flight school	2	4	0	4	0
Pilots arrived at a time that allowed for training prior to deployment	0	3	3	4	0
The USAACE provides enough pilots to fill the Battalion to 100% manning	1	5	0	3	1
The USAACE provides pilots IAW the ARFORGEN model	0	2	1	7	0

Instructor Pilots (Pilots 2010)***:***

1. What type of Aircraft are you an Instructor Pilot for?	**AH-64**	**OH-58D**	**CH-47**	**UH-60**
	8	8	3	8

2. What Aspects of FS XXI do you Value?										
	How Important is this?					How Well does the Enterprise accomplish this?				
	Very				Not Very	Very Well				Not Well
	5	4	3	2	1	5	4	3	2	1
Quality of Aviatior Produced	27					3	13	8	3	
Timeliness of Aviatior Produced	4	12	8	1	2	1	5	12	8	1
Efficient Use of Resouces	9	18				2	11	6	7	1
Ability to graduate students on time	7	10	7	2	1	1	11	8	6	1
Professional Development	10	13	2		2	2	13	9	3	0
Predictable Work Schedule	10	7	7	2	1	5	10	6	4	2

3. Enterprise Architecture Views										
	How Important is this?					How much influence do you feel you have on this?				
	Very				Not Very	A lot				Not Much
	5	4	3	2	1	5	4	3	2	1
Strategy	12	11	3	0	0	3	2	7	7	7
Policy	15	9	2	0	0	3	4	2	8	9
Process	12	13	1	0	0	6	3	9	6	2
Product	25	1	0	0	0	13	9	3	1	0
Information	13	8	3	2	0	2	3	13	7	1
Knowledge	19	7	0	0	0	14	8	4	0	0
Organization	2	12	10	1	1	0	1	0	8	17

Please Rate the Following	Strongly Agree				Strognly Disagree
	5	4	3	2	1
The current POI is effective in training new pilots	5	14	5	7	0
The current flight hours in the POI are sufficient to accomplish daily training tasks	1	13	4	5	3
The bubble degradesnew pilots skills between the Common Course and Advanced Aircraft	16	8	1	1	0
A significant amount of time is spent relearning basic aviator skills	12	11	3	0	0
Time spent re-learning basic aviator skills affects the training tasks prescribed by the POI	14	9	3	0	0
Weather often affects pilot training	14	6	6	0	0
A lack of resources often affects pilot training	12	8	4	2	0
Would additional days for "IP Select Training" be effective to improve training	11	6	7	1	1

USAACE Leadership (Leadership 2010)***:***

1. What Aspects of FS XXI do you Value?										
	How Important is this?					How Well does the Enterprise accomplish this?				
	Very				Not Very	Very Well				Not Well
	5	4	3	2	1	5	4	3	2	1
Quality of Aviatior Produced	2	1				2	1			
Timeliness of Aviatior Produced		3						1	2	
Efficient Use of Resouces		3						1	2	
Ability to graduate students on time		2	1				1	1		
Professional Development	1	1	1			1		1	1	
Predictable Work Schedule		2		1		1	1	1		

2. Enterprise Architecture Views										
	How Important is this?					How much influence do you feel you have on this?				
	Very				Not Very	A lot				Not Much
	5	4	3	2	1	5	4	3	2	1
Strategy	3	0	0	0	0	0	0	0	2	1
Policy	1	1	1	0	0	0	0	0	1	2
Process	1	2	0	0	0	0	0	2	1	0
Product	3	0	0	0	0	0	0	2	1	0
Information	2	1	0	0	0	0	0	2	1	0
Knowledge	1	1	1	0	0	0	0	1	2	0
Organization	1	2	0	0	0	0	0	0	3	0

Flight School XXI Team (FSXXI 2010)***:***

1. What Aspects of FS XXI do you Value?										
	How Important is this?					How Well does the Enterprise accomplish this?				
	Very				Not Very	Very Well				Not Well
	5	4	3	2	1	5	4	3	2	1
Quality of Aviatior Produced	2						2			
Timeliness of Aviatior Produced	1	1							1	1
Efficient Use of Resouces	1	1						1		1
Ability to graduate students on time	1	1							1	1
Professional Development	2							1	1	
Predictable Work Schedule	1	1						1		1

2. Enterprise Architecture Views										
	How Important is this?					How much influence do you feel you have on this?				
	Very				Not Very	A lot				Not Much
	5	4	3	2	1	5	4	3	2	1
Strategy	2	0	0	0	0	0	1	1	0	0
Policy	1	1	0	0	0	0	1	1	0	0
Process	1	1	0	0	0	0	0	2	0	0
Product	2	0	0	0	0	0	0	2	0	0
Information	1	1	0	0	0	0	0	1	1	0
Knowledge	1	1	0	0	0	0	0	1	1	0
Organization	2	0	0	0	0	0	0	0	2	0

Students (Students 2010)***:***

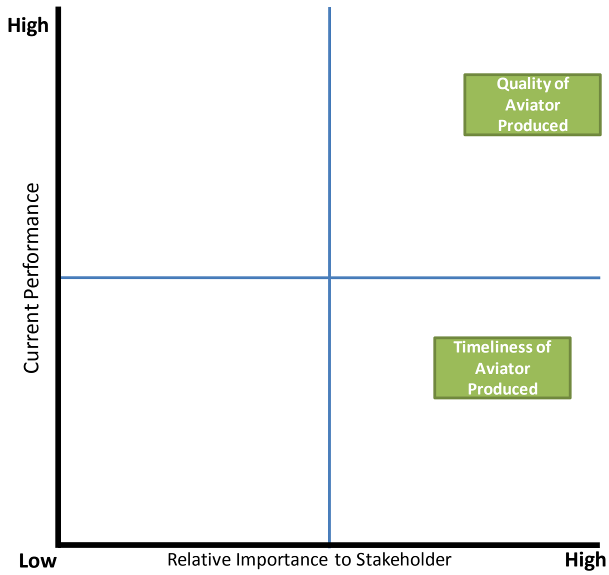
1. What phase of training are you currently in?	**BOLC**	**Pre-IERW**	**IERW Core**	**Adv. A/C**	**Other**
	1	2	2	5	3

2. What Aspects of FS XXI do you Value?										
	How Important is this?					How Well does the Enterprise accomplish this?				
	Very				Not Very	Very Well				Not Well
	5	4	3	2	1	5	4	3	2	1
Quality of Training Received	13					4	8	1		
Professionalism of IP	9	3				3	5	2	1	
Minimize Time at Ft. Rucker	3	3	3	2	2		1	3	7	2
Choice of A/C	8	3	1		1	2	8	2	1	
Choice of Duty Station	4	5	3		1	1	6	5		1

3. Enterprise Architecture Views										
	How Important is this?					How much influence do you feel you have on this?				
	Very				Not Very	A lot				Not Much
	5	4	3	2	1	5	4	3	2	1
Strategy	3	7	2	0	0	0	2	0	5	5
Policy	5	7	0	0	0	0	0	2	5	5
Process	3	8	1	0	0	0	2	4	4	2
Product	10	2	0	0	0	5	1	4	2	0
Information	5	7	0	0	0	0	3	4	4	1
Knowledge	7	3	1	1	0	1	4	5	1	1
Organization	2	3	4	3	0	0	1	1	7	3

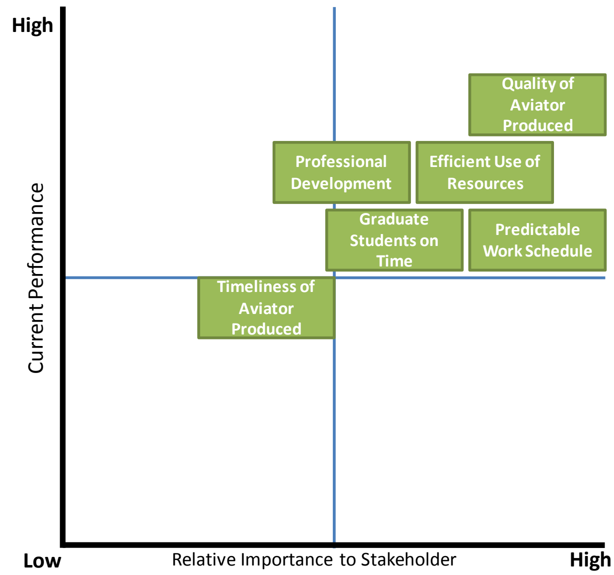
B-4: Stakeholder Value Delivery Charts

CAB Battalion Commanders:



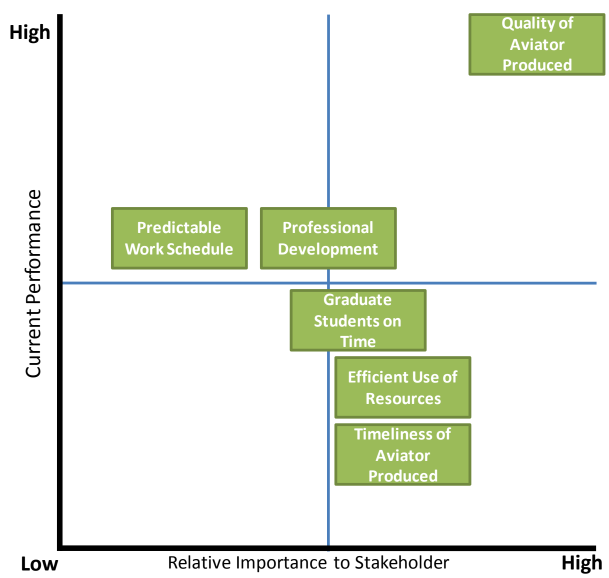
Value Delivery CAB Battalion Commanders (Commanders 2010)

Instructor Pilots:



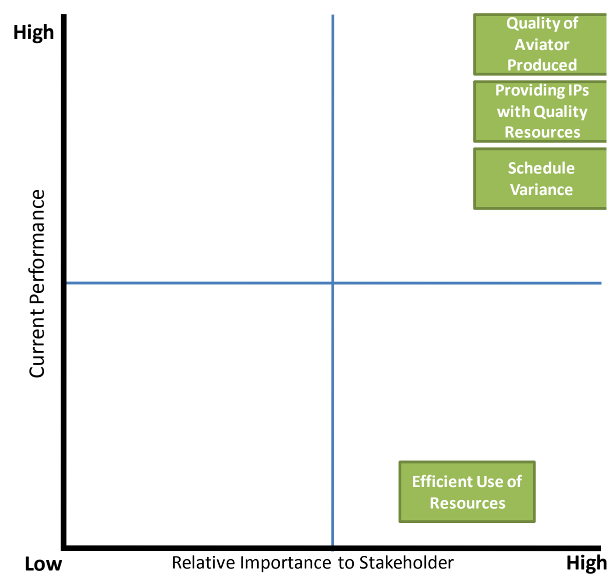
Value Delivery Instructor Pilots (Pilots 2010)

USAACE Leadership:



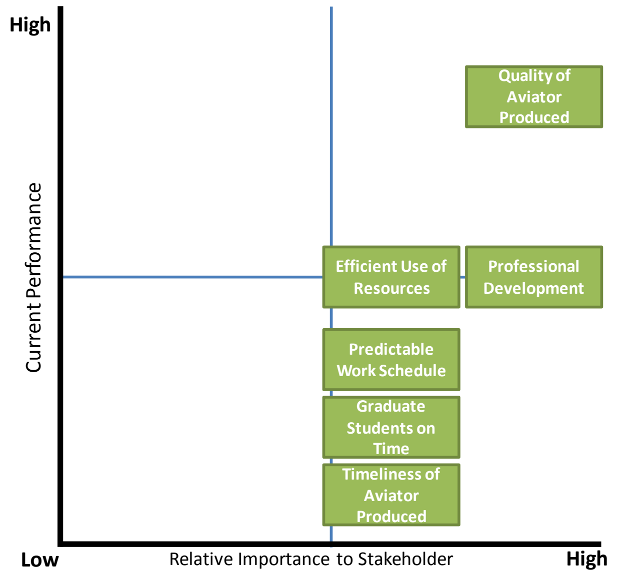
Value Delivery USAACE Leadership (Leadership, Flight School XXI Leadership Survey 2010)

Simulation Center:



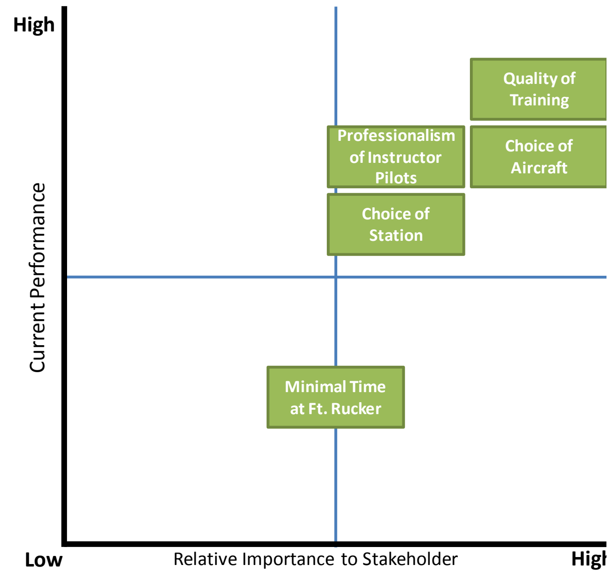
Value Delivery Simulation Center (CSC 2009)

Flight School XXI Team:



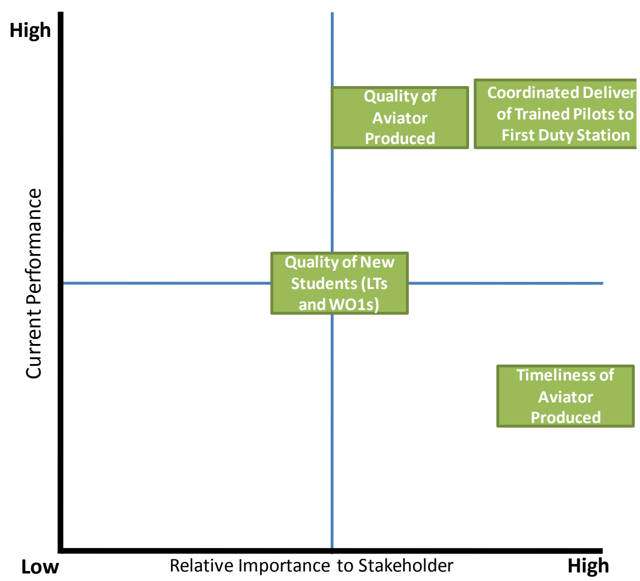
Value Delivery Flight School XXI Team (FSXXI 2010)

Students:



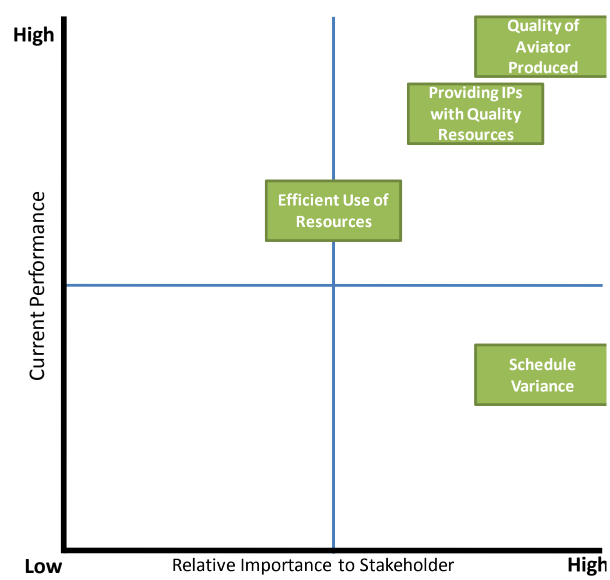
Value Deliver Students (Students 2010)

HRC:



Value Delivery HRC (Representative 2009)

ACLC/AFS:



Value Delivery ACLC/AFS (AFS 2009)

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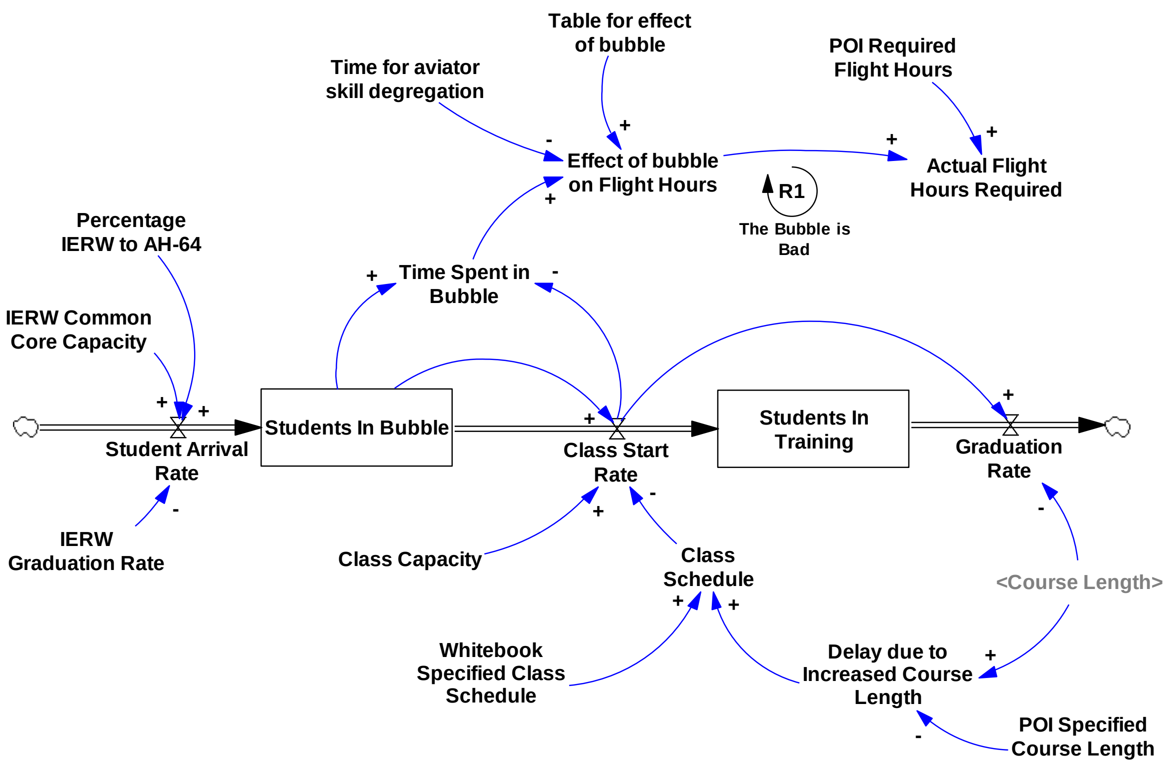
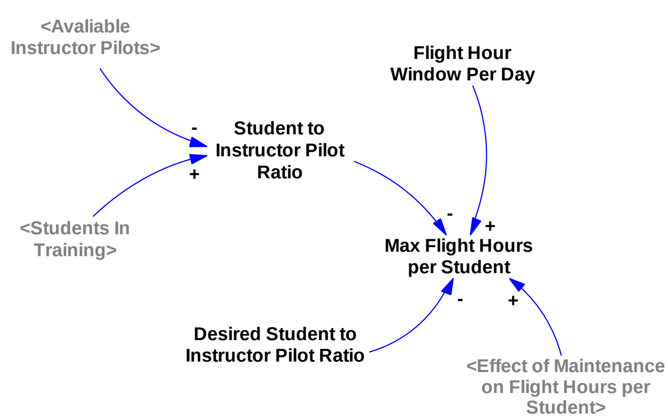
Appendix C: System Dynamics Model

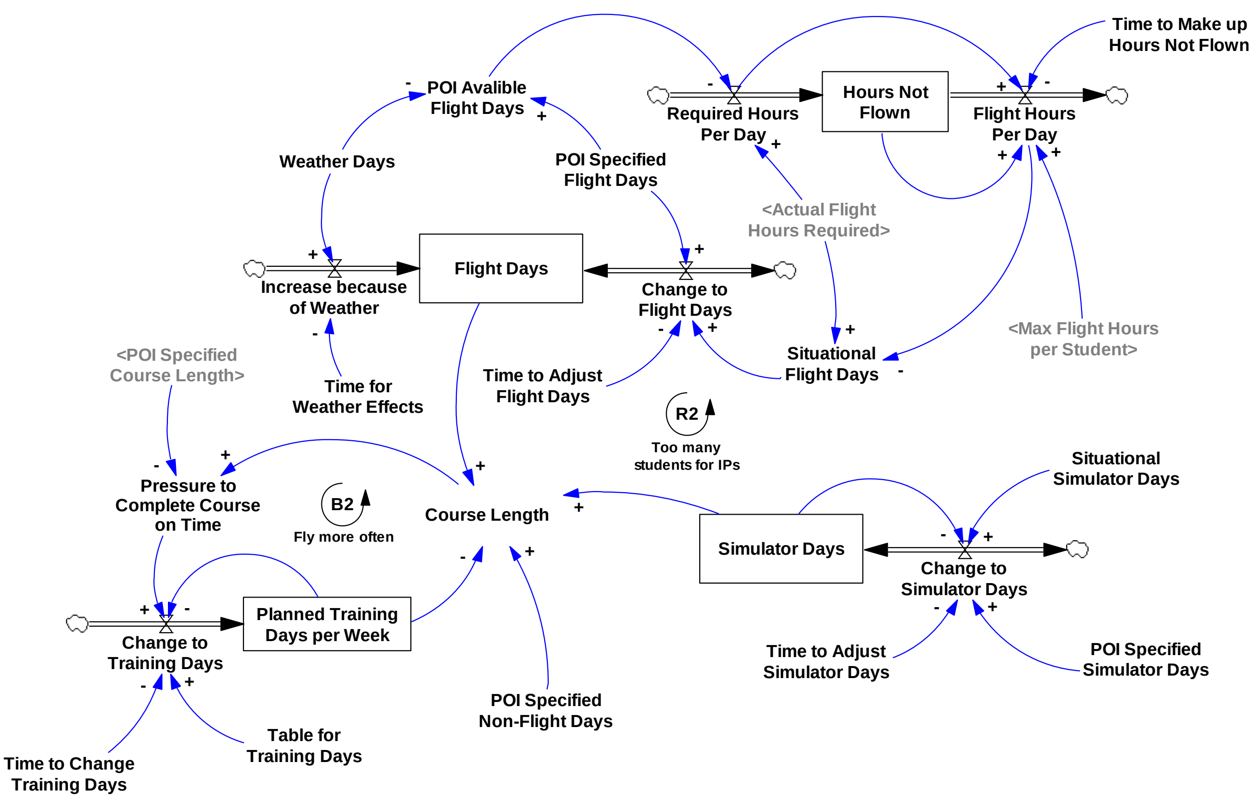
C-1: Student Sub-Model



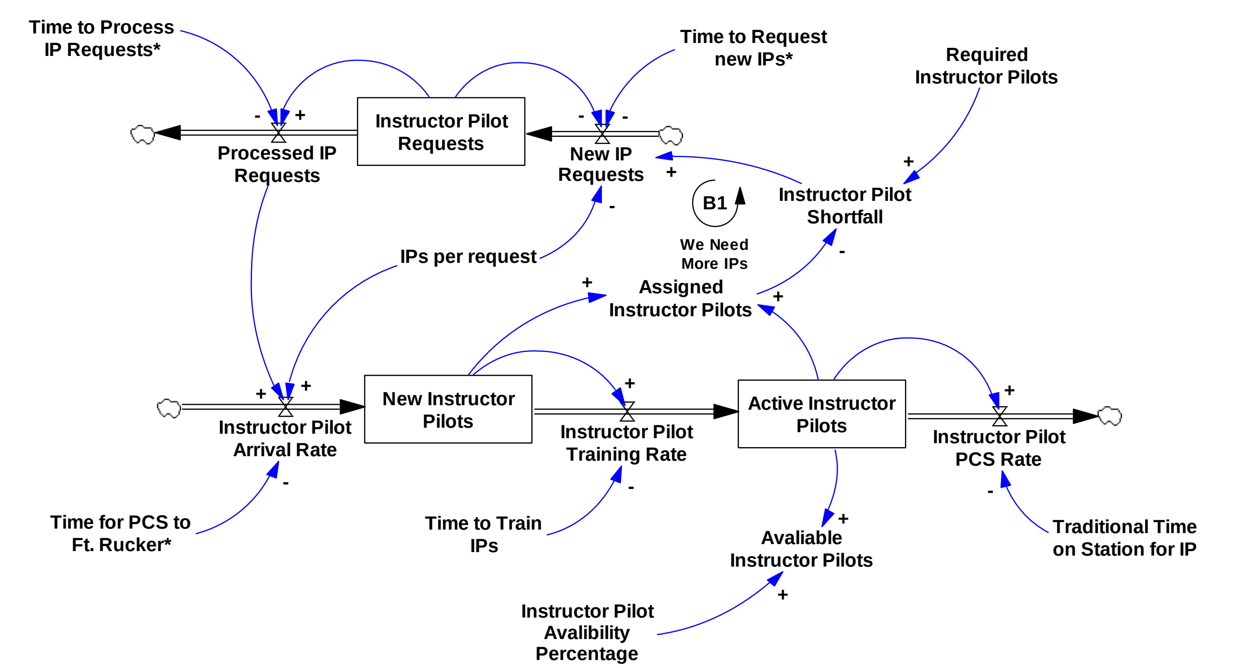
C-2: Training Sub-Model



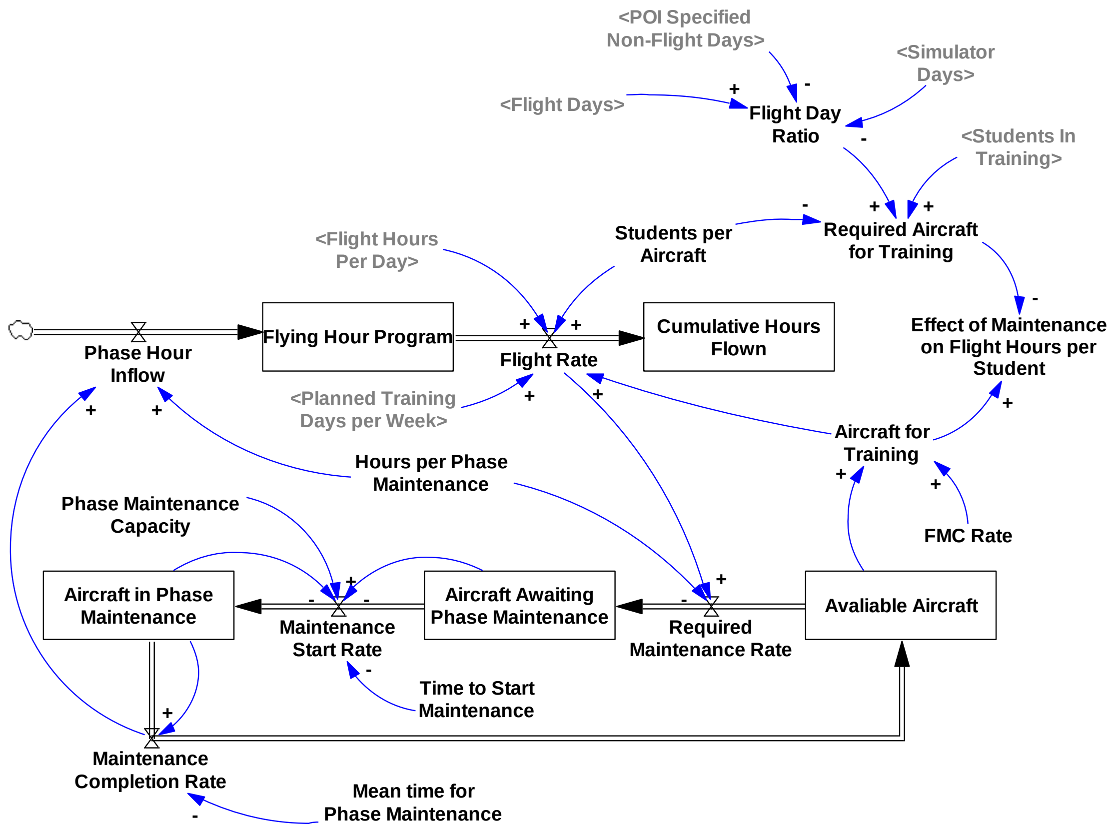
C-3: Course Length Sub-Model



C-4: Instructor Pilot Sub-Model



C-5: Maintenance Sub-Model



C-6: Equation List

Process View

Actual Flight Hours Required=Effect of bubble on Flight Hours*POI Required Flight Hours
Units: Hour
The actual number of flight hours required to complete the tasks in the POI and re-learn basic aviator skills that were degraded while in the bubble

Change to Flight Days= (Situational Flight Days-POI Specified Flight Days)/Time to Adjust Flight Days
Units: Day/Week

Change to Simulator Days=MAX((Situational Simulator Days-Simulator Days)/Time to Adjust Simulator Days,(POI Specified Simulator Days-Simulator Days)/Time to Adjust Simulator Days)
Units: Day/Week
The change in the number of simulator days based on the current situation

Change to Training Days=(Table for Training Days(Pressure to Complete Course on Time)-Planned Training Days per Week)/Time to Change Training Days
Units: Days/Week/Week
The increase or decrease the number of planned training days per week based on the delay caused by an increase in course length.

Class Start Rate=min(Students In Bubble,Class Capacity)/Class Schedule
Units: Student/Week
The number of students who are beginning the course

Course Length=(Flight Days + POI Specified Non-Flight Days + Simulator Days)/Planned Training Days per Week
Units: Week
The course length

Cumulative Hours Flown= INTEG (Flight Rate,0)
Units: Hour
The cumulative hours flown by the AH-64 program

Delay due to Increased Course Length=MAX(0,Course Length-POI Specified Course Length-2)
Units: Week
The delay in starting the next course if a class runs over the scheduled more than the two weeks between classes

Flight Days= INTEG (Increase because of Weather + Change to Flight Days,POI Specified Flight Days)
Units: Day
The actual number of flight days required for the course

Flight Hours Per Day =min(Max Flight Hours per Student,(Hours Not Flown/Time to Make up Hours Not Flown)+Required Hours Per Day)
Units: Hour/Day
The actual number of flight hours flown per day.

Flight Rate= Flight Hours Per Day*Planned Training Days per Week*Aircraft for Training *Students per Aircraft
Units: Hour/Week
The flight rate for the aircraft

Graduation Rate=DELAY FIXED (Class Start Rate, Course Length, 5.5)
Units: Student/Week
The graduation rate based on the number of students that start and the time spent in the course

Hours Not Flown= INTEG (Required Hours Per Day-Flight Hours Per Day,0)
Units: Hour
Hours that were required to be flow, but were unable to be flown

Max Flight Hours per Student=min(Flight Hour Window Per Day/Desired Student to Instructor Pilot Ratio, Flight Hour Window Per Day/Student to Instructor Pilot Ratio)*Effect of Maintenance on Flight Hours per Student
Units: Hour/Day
The max flight hours per student based on the number of instructor pilots available

POI Available Flight Days=POI Specified Flight Days-Weather Days
Units: Day
The number of days according to the POI less the weather days, which increases the pressure to fly more per day to make up for weather days

Pressure to Complete Course on Time=Course Length/POI Specified Course Length
Units: Dmnl
The pressure to complete the course on time

Required Aircraft for Training= Flight Day Ratio*Students In Training/Students per Aircraft
Units: Aircraft
The number of required aircraft based on the number of students in training

Required Hours Per Day=Actual Flight Hours Required/POI Avalible Flight Days
Units: Hour/Day
The number of hours required to be flown per day to ensure that the course is completed on time

Simulator Days= INTEG (Change to Simulator Days, POI Specified Simulator Days)
Units: Day
The number of simulator days required for the course.

Situational Flight Days= (Actual Flight Hours Required/Flight Hours Per Day)
Units: Day
The number of flight days required to complete the POI and any remedial training

Situational Simulator Days= 0
Units: Day

Student Arrival Rate= IERW Common Core Capacity*Percentage IERW to AH-64/IERW Graduation Rate
Units: Student/Week
The number of students that arrive each week from the Common Core Course, initially set at 5.5 to keep the system in equilibrium

Student to Instructor Pilot Ratio= Students In Training/Available Instructor Pilots
Units: Student/IP
The actual ratio of students to instructor pilots based on the assigned instructor pilots and students in training

Students per Aircraft=2
Units: 1/Aircraft
The number of students that will fly each aircraft

Time Spent in Bubble= Students In Bubble/Class Start Rate
Units: Week
The average number of weeks spent in the bubble.

Time to Adjust Flight Days= 1
Units: Week
The time required to adjust the flight days, initially set to 1 for an instantaneous change

Time to Adjust Simulator Days= 1
Units: Week
The time required to adjust the simulator days, initially set to 1 for an instantaneous change

Time to Change Training Days= 2
Units: Week
The amount of time required to realize that the delays will have an impact on the course length and adjust the number of planned training days per week

Time to Make up Hours Not Flown=1
Units: Day
The amount of time desired to make up any hours not flown

Strategy View

Class Capacity=22
Units: Student
The class capacity for the AH-64 course; initially set to 22 as per Whitebook

Class Schedule=Whitebook Specified Class Schedule + Delay due to Increased Course Length
Units: Week
The number of weeks between class starts accounting for possible delays

Desired Student to Instructor Pilot Ratio=2
Units: Student/IP
The desired student to instructor pilot, set at a desired ratio of 2 students per IP

Flight Day Ratio= Flight Days/(Flight Days+"POI Specified Non-Flight Days"+Simulator Days)
Units: Dmnl
The ratio of flight days to the course length, the percentage of the course that will be spent flying

Flight Hour Window Per Day= 3
Units: Student*Hour/IP/Day
The training window set by the USAACE, initially set at 3 hours per instructor pilot

IERW Common Core Capacity=50
Units: Student
The total number of graduates from the IERW Common Core Course

IERW Graduation Rate= 2
Units: Week
The number of weeks between IERW Graduations, set to 2 weeks as per the Whitebook

Percentage IERW to AH-64=0.22
Units: Dmnl
The percentage of IERW graduates that will attend the AH-64 Course

Planned Training Days per Week= INTEG (Change to Training Days, 5)
Units: Day/Week
The number of training days per week

POI Required Flight Hours= 89.4
Units: Hour
The number of flight hours required by the POI, set to 89.4 as per the AH-64 POI

POI Specified Course Length=21.4
Units: Week
The POI Specified course length for the AH-54 course it is set at 21.4 weeks

POI Specified Flight Days= 79
Units: Day
The number of POI Specified days for flight training, set at 79 as per the AH-64 POI

POI Specified Non-Flight Days= 8
Units: Day
The number of POI days that no flight or simulation training is planned, set at 8 as per POI

POI Specified Simulator Days=20
Units: Day
The number of training days in the flight simulator as per the POI, set at 20 as per the POI

Whitebook Specified Class Schedule = 4
Units: Week
The number of weeks between class starts as specified in the Ft. Rucker Whitebook, initially set as 4 weeks for the AH-64 course

Organization View

Active Instructor Pilots= INTEG (Instructor Pilot Training Rate-Instructor Pilot PCS Rate, 101)
Units: IP
The total number of active instructor pilots at Ft. Rucker, initally set at 91, the current manning for AH-64 Instructor Pilots is 101, of which 10 are assumed to be in training

Aircraft Awaiting Phase Maintenance = INTEG (Required Maintenance Rate-Maintenance Start Rate, 2)
Units: Aircraft
The number of aircraft that are awaiting phase maintenance

Aircraft for Training = Available Aircraft*FMC Rate
Units: Aircraft
Aircraft actually available for training after taking into account unscheduled maintenance

Aircraft in Phase Maintenance=INTEG(Maintenance Start Rate-Maintenance Completion Rate,6)
Units: Aircraft
The number of aircraft that are in phase maintenance, initially set at 6, the current capacity

Assigned Instructor Pilots = Active Instructor Pilots + New Instructor Pilots
Units: IP
The total number of assigned instructor pilots for the AH-64 Course

Available Aircraft= INTEG (Maintenance Completion Rate-Required Maintenance Rate, 50)
Units: Aircraft
The number of available A/C that are not in or awaiting phase maintenance, initial value 50

Available Instructor Pilots= Active Instructor Pilots*Instructor Pilot Availability Percentage
Units: IP
The number of available instructor pilots based on IP Availability Percentage

Effect of Maintenance on Flight Hours per Student=min(1,Aircraft for Training/Required Aircraft for Training)
Units: Dmnl
The average effect for maintenance on the flight hours per student, a lack of aircraft will affect the max flight hours per student; constrained to a maximum of 1 because aircraft in excess of required will not decrease training

Flying Hour Program= INTEG (Phase Hour Inflow-Flight Rate, 10000)
Units: Hour
The amount of flight hours in the flying hour program

FMC Rate=0.79
Units: Dmnl
The FMC Rate for aircraft; represents the percentage of time that an available aircraft is mission capable, not including scheduled maintenance

Instructor Pilot Availability Percentage= 0.57
Units: Dmnl
The percentage of active instructor pilots that are actually available for training based on leave, medical issues, etc, initially set at 57% from survey data for leave and illness. Also, not all assigned instructor pilots fly for the AH-64 Advanced Aircraft Course

Instructor Pilot Requests= INTEG (New IP Requests-Processed IP Requests, 14)
Units: Request
The number of IP request being processed by HRC, set at 14 to initial have system in equilibrium

Instructor Pilot Shortfall=Required Instructor Pilots-Assigned Instructor Pilots
Units: IP
The number of instructor pilots that the course is short, equals the required instructor pilots less the active instructor pilots

IPs per request=1
Units: IP/Request
The number of IPs per request, assumed that there is one Instructor Pilot per request to maintain units during simulation

Maintenance Completion Rate= Aircraft in Phase Maintenance/Mean time for Phase Maintenance
Units: Aircraft/Week
The maintenance completion rate with a delay of the mean time for phase maintenance

Maintenance Start Rate=min((Phase Maintenance Capacity-Aircraft in Phase Maintenance)/Time to Start Maintenance, Aircraft Awaiting Phase Maintenance/Time to Start Maintenance)
Units: Aircraft/Week
The start time for phase maintenance, based on the completion of aircraft

Mean time for Phase Maintenance= 4
Units: Week
The average amount of time to complete phase maintenance, initially set at 4 weeks

New Instructor Pilots= INTEG (Instructor Pilot Arrival Rate-Instructor Pilot Training Rate, 9)
Units: IP
The number of new instructor pilots awaiting training at Ft. Rucker

New IP Requests=MAX(0.2,(Instructor Pilot Shortfall/IPs per request-Instructor Pilot Requests)/Time to Request new IPs)
Units: Request/Week
The new IP request rate from the Brigade S1 to HRC

Phase Hour Inflow= Maintenance Completion Rate*Hours per Phase Maintenance
Units: Hour/Week
The amount of hours that are added to the flying hour program when an aircraft completes phase maintenance

Phase Maintenance Capacity = 6
Units: Aircraft
The number of aircraft that can be in phase maintenance at one time

Processed IP Requests=Instructor Pilot Requests/Time to Process IP Requests
Units: Request/Week
The number of IP requests filled by HRC resulting in PCS orders cut for an instructor pilot

Required Instructor Pilots= 150
Units: IP
The number of required Instructor Pilots according to the USAACE authorized manning

Required Maintenance Rate= Flight Rate/Hours per Phase Maintenance
Units: Aircraft/Week
The rate at which aircraft require phase maintenance

Time to Request new IPs= 12
Units: Week
The amount of time for the Brigade S1 to request new instructor pilots from HRC, assumed a time of 12 weeks initially

Time to Start Maintenance= 1
Units: Week
The amount of time required to start phase maintenance, set at 1 week for an instantaneous start

Traditional Time on Station for IP=156
Units: Week
The average amount of time spent on Ft. Rucker as an instructor Pilot; set at 156 weeks (3 Years)

Knowledge View

Instructor Pilot Training Rate= min(1.08,New Instructor Pilots/Time to Train IPs)
Units: IP/Week
The training rate for new IPs upon arrival to Ft. Rucker through the IP MOI or IPC Course, constrained to a maximum of 1.08 because there are only 54 slots for the IPC course per year

Time for aviator skill degradation= 8
Units: Week
The amount of time spent in the bubble before an aviator's skills begin to degrade. Initially set at 8 weeks

Time to Train IPs= 14
Units: Week
The amount of time spent in the IP MOI course, set to 14 weeks which includes 2 weeks for inprocessing and an additional 12 weeks for the AH-64 IPC course

Product View

Effect of bubble on Flight Hours=Table for effect of bubble(Time Spent in Bubble/Time for aviator skill degradation)
Units: Dmnl
The effect of the bubble on the actual flight hours required for a student

Students In Bubble= INTEG (Student Arrival Rate-Class Start Rate, 22)
Units: Student
The number of students in the bubble awaiting training, initially set to 22 students to have enough students to start the first class

Students In Training= INTEG (Class Start Rate-Graduation Rate, 22*6)
Units: Student
The number of students in training at any point in time

Policy/External Factors View

Hours per Phase Maintenance=750
Units: Hour/Aircraft
The amount of hours per aircraft that phase maintenance gives to the flying hour program, represents that an aircraft can fly 750 hours between phase maintenance

Increase because of Weather= Weather Days/Time for Weather Effects

Units: Day/Week

The number of weather days, which increase the number of flight days required to complete the course, however, this can be compensated for by flying more hours during the day

Instructor Pilot Arrival Rate= DELAY FIXED((Processed IP Requests*IPs per request), Time for PCS to Ft. Rucker, 0.4)

Units: IP/Week

The arrival rate of instructor pilots to Ft. Rucker once they have orders from HRC. Initially set to 0.4

Instructor Pilot PCS Rate=Active Instructor Pilots/Traditional Time on Station for IP

Units: IP/Week

The PCS rate for instructor pilots based on the traditional time spent on station for an instructor pilot

Time for PCS to Ft. Rucker=12

Units: Week

The amount of time required to PCS to Ft. Rucker upon receipt of orders set at 12 weeks to account for time required to clear current duty station, move to Ft. Rucker, any PCS leave enroute, and time to inprocess Ft. Rucker

Time for Weather Effects= 1

Units: Week

Time for the weather to effect training, set to 1 because of instant effects

Time to Process IP Requests= 24

Units: Week

The amount of time required for HRC to identify a potential instructor pilot and cut orders for that individual; initially assumed to be 24 weeks

Weather Days=integer(RANDOM NORMAL(0,5, 0.962, 0.929, 1))

Units: Day

The number of weather days, which increase the number of flight days required to complete the course, however, this can be compensated for by flying more hours during the day

Tables

Table for effect of bubble

Units: Dmnl

The amount of extra time required for students to re-learn basic aviator tasks due to skill degregation while in the bubble.

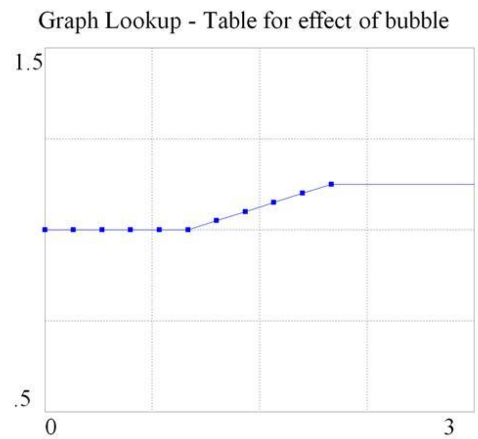
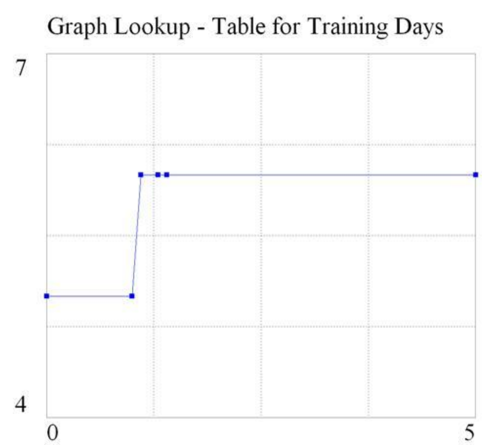


Table for Training Days

Units: Day/Week



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Appendix D: Future State Data

D-1: Future State Program of Instruction (POI)

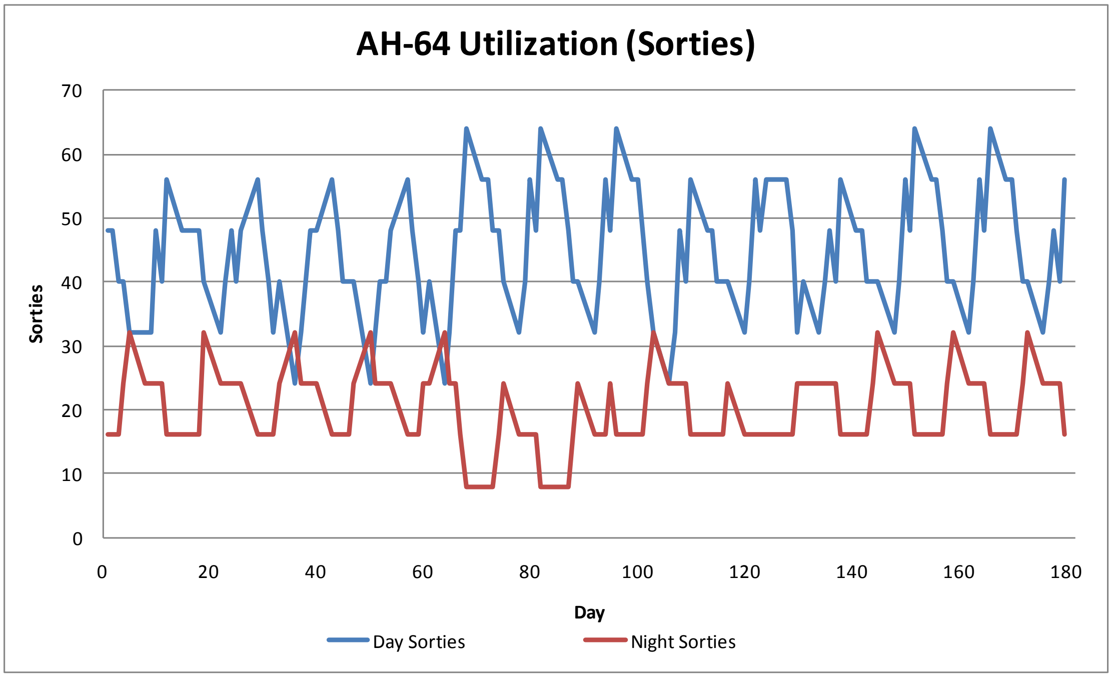
Phase	Phase I: Transition																						Phase II: Instrument/BCS															
Training Day	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130	131	B1	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147
Students	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16
Day Flight Hour								1	1	1.1	1.1	1.2	1.2	1.2	1.2		1.2	1.2	1.2	1.2	1.2	1						1	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Night Flight Hour																																						
SIM Hours			1.4	1.4	2.8											2.8							1.4	2.8	2.8	2.8	2.8											
Gunnery Range																																						
Total Day	0	0	0	0	0	0	0	16	16	18	18	19	19	19	19	0	19	19	19	19	19	16	0	0	0	0	0	16	19	19	19	19	19	19	19	19	19	19
Total Night	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total SIM	0	0	22	22	45	0	0	0	0	0	0	0	0	0	0	45	0	0	0	0	0	0	22	45	45	45	45	0	0	0	0	0	0	0	0	0	0	0
Gunnery Range	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

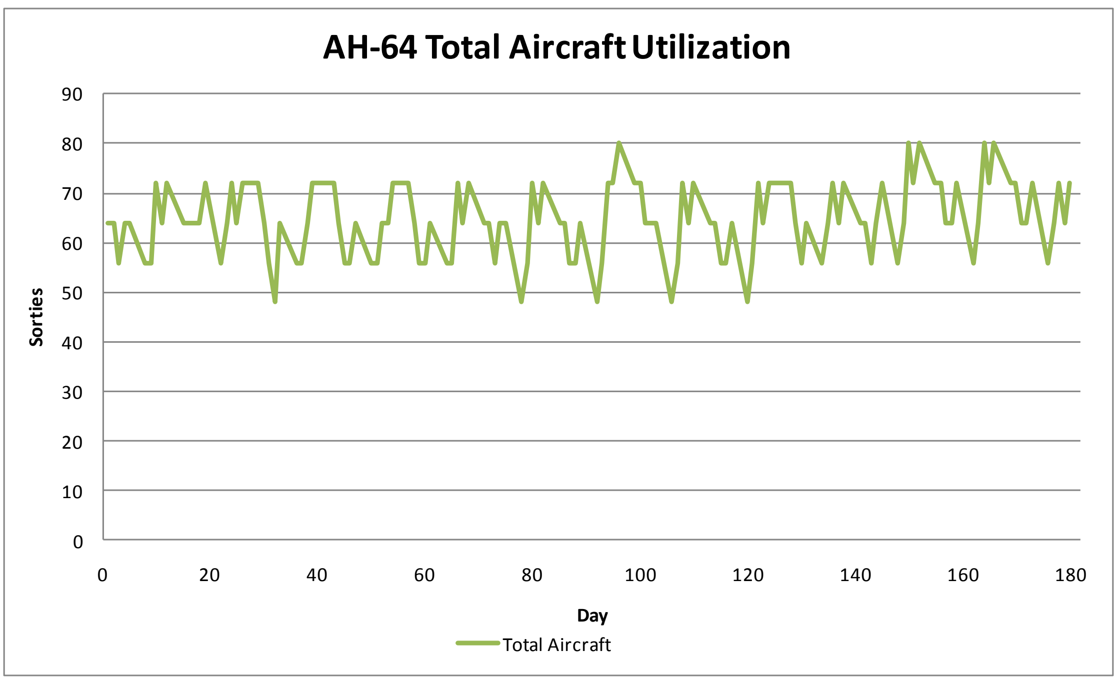
Phase	Phase III: Stage I: Day Systems																			Phase III: Stage II: Night/Night Vision Systems															
Training Day	148	149	150	151	152	153	B2	154	155	156	157	157	159	160	161	162	163	164	B3	165	166	167	168	168	170	171	172	173	174	175	176	177	178	179	B4
Students	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16
Day Flight Hour		1	1	1	1	1	1	1	1	1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1																
Night Flight Hour																					1	1.2	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.4	1
SIM Hours	2.8																																		
Gunnery Range																																			
Total Day	0	16	16	16	16	16	16	16	16	16	18	18	18	18	18	18	18	18	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Night	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	16	19	18	18	18	18	18	18	18	18	18	18	18	22	16
Total SIM	45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gunnery Range	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Phase	Phase III: Stage III: NVG					Phase IV: Gunnery																							
Training Day	180	181	182	183	184	185	186	187	188	189	190	191	192	193	194	195	196	197	198	199	B5	200	201	202	203	204	205	206	207
Students	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16
Day Flight Hour												1	1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1							1.1	
Night Flight Hour	1.2	1.2	1.2	1.2	1.2																	1.1	1.1	1.1	1.1	1.1	1.1		
SIM Hours							2.8	2.8	2.8	2.8	2.8																		2.8
Gunnery Range												1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
Total Day	0	0	0	0	0	0	0	0	0	0	0	16	16	18	18	18	18	18	18	18	16	0	0	0	0	0	0	18	0
Total Night	19	19	19	19	19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	18	18	18	18	18	18	0	0
Total SIM	0	0	0	0	0	0	45	45	45	45	45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	45
Gunnery Range	0	0	0	0	0	0	0	0	0	0	0	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	0

Phase	Phase V: ACS								Class Buffer			
Training Day	208	209	210	211	212	213	214	215	B6	B7	B8	B8
Students	16	16	16	16	16	16	16	16	16	16	16	16
Day Flight Hour			1.5				2.5	2.5	1	1	1	1
Night Flight Hour				1.5								
SIM Hours	2.8	2.8										
Gunnery Range												
Total Day	0	0	24	0	0	0	40	40	16	16	16	16
Total Night	0	0	0	24	0	0	0	0	0	0	0	0
Total SIM	45	45	0	0	0	0	0	0	0	0	0	0
Gunnery Range	0	0	0	0	0	0	0	0	0	0	0	0

D-2: Future State Resource Utilization





D-3: Future State Bubble Model[5]

Class Capacity	Q3&4	Q1&2	Q3&4	Q1&2	Q3&4
IERW CC	52	54	60	60	64
UH-60	26	28	28	30	30
CH-47	14	6	8	8	8
OH-58D	12	6	8	10	10
AH-64	22	12	14	16	16
New Student Arrivals	26.5				

	Q3&4	Q1&2	Q3&4	Q1&2	Q3&4
UH-60	0.51	0.51	0.50	0.50	0.47
CH-47	0.16	0.16	0.14	0.11	0.12
OH-58D	0.12	0.13	0.12	0.14	0.16
AH-64	0.21	0.20	0.24	0.25	0.25

Scheduled Capacity

	FY 10																							
Week	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
BOLC B	0	0	0	0	52	0	52	0	52	0	52	0	52	0	52	0	52	0	52	0	52	0	52	0
IERW-CC	0	0	0	0	0	0	52	0	52	0	52	0	52	0	52	0	52	0	52	0	52	0	52	0
UH-60	26	0	26	0	26	0	26	0	26	0	26	0	26	0	26	0	26	0	26	0	26	0	26	0
CH-47	14	0	0	0	14	0	0	0	14	0	0	0	14	0	0	0	14	0	0	0	14	0	0	0
OH-58D	12	0	0	0	12	0	0	0	12	0	0	0	12	0	0	0	12	0	0	0	12	0	0	0
AH-64	22	0	0	0	22	0	0	0	22	0	0	0	22	0	0	0	22	0	0	0	22	0	0	0

Students Entering Course

	FY 10																							
Week	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
BOLC B	0	0	0	0	52	0	52	0	52	0	52	0	52	0	52	0	52	0	52	0	52	0	52	0
IERW-CC	0	0	0	0	0	0	52	0	52	0	52	0	52	0	52	0	52	0	52	0	52	0	52	0
UH-60	26	0	26	0	26	0	26	0	26	0	26	0	26	0	26	0	26	0	26	0	26	0	26	0
CH-47	14	0	0	0	14	0	0	0	14	0	0	0	14	0	0	0	14	0	0	0	14	0	0	0
OH-58D	12	0	0	0	12	0	0	0	12	0	0	0	12	0	0	0	12	0	0	0	12	0	0	0
AH-64	22	0	0	0	22	0	0	0	22	0	0	0	22	0	0	0	22	0	0	0	22	0	0	0

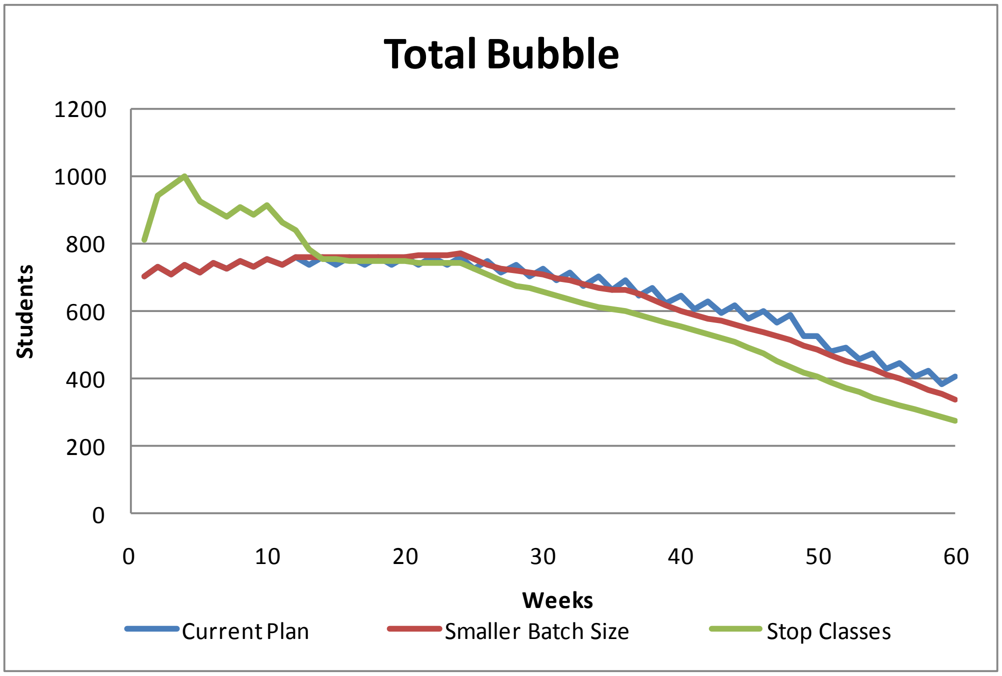
Students Graduating Courses

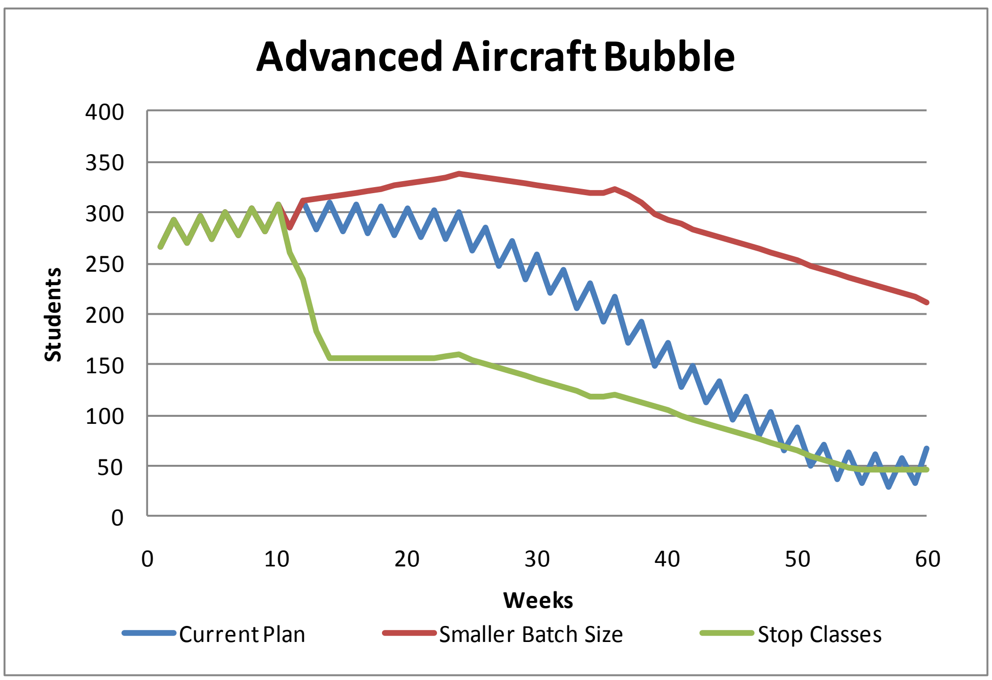
	FY 10																							
Week	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
BOLC B	52		52		52		52		0	0	0	0	52	0	52	0	52	0	52	0	52	0	52	0
IERW-CC		52		52		52		52		52		52		52		52		52		52		0	0	0
UH-60																	26	0	26	0	26	0	26	0
CH-47																		14	0	0	0	14	0	0
OH-58D																					12	0	0	0
AH-64																								22

Students in Bubble

		FY 10																							
Week		25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
BOLC B	375	402	428	455	481	456	482	457	483	458	484	459	485	460	486	461	487	462	488	463	489	464	490	465	491
IERW-CC	76	128	128	180	180	232	232	232	232	180	180	128	128	128	128	128	128	128	128	128	128	128	128	128	128
UH-60	137	111	138	112	138	112	139	113	139	113	140	114	140	114	141	115	141	115	142	116	142	116	116	90	90
CH-47	17	3	11	11	20	6	14	14	22	8	17	17	25	11	19	19	28	14	22	22	30	16	16	16	16
OH-58D	59	47	53	53	59	47	54	54	60	48	54	54	60	48	55	55	61	49	55	55	61	49	49	49	49
AH-64	101	79	90	90	101	79	90	90	101	79	90	90	101	79	89	89	100	78	89	89	100	78	78	78	78
Total	765	770	848	901	979	932	1010	959	1037	886	964	861	939	840	918	867	945	846	924	873	951	852	878	827	853

[5] The table only depicts the 3rd and 4th quarter of FY 10.


Total Bubble
1200
1000
800
600
400
200
0
Students
0
10
20
30
40
50
60
Weeks
Current Plan
Smaller Batch Size
Stop Classes


Advanced Aircraft Bubble
400
350
300
250
200
150
100
50
0
Students
0
10
20
30
40
50
60
Weeks
Current Plan
Smaller Batch Size
Stop Classes

D-4: Probabilistic Course Model

Phase	Phase I: Transition																				
Training Day	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130	131	B1
Day Flight Hour								1	1	1.1	1.1	1.2	1.2	1.2	1.2		1.2	1.2	1.2	1.2	1.2	
Night Flight Hour																						
SIM Hours			1.4	1.4	2.8											2.8						
Cum Day		0	0	0	0	0	0	1	2	3.1	4.2	5.4	6.6	7.8	9	9	10.2	11.4	12.6	13.8	15	15
Cum Night		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cum SIM		0	1.4	2.8	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	8.4	8.4	8.4	8.4	8.4	8.4	8.4
Weather	1	1	0	1	0	1	1	0	1	1	1	1	1	0	1	1	1	1	1	1	0	1
Max Flight Hours	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75

Actual Hours	Phase I: Transition																				
Day Flight Hour	0	0	0	0	0	0	0	0	1.75	1.35	1.1	1.2	1.2	0	1.75	0.65	0	1.75	1.75	1.3	0	1.2
Night Flight Hour																						
SIM Hours	0	0	1.4	1.4	2.8	0	0	0	0	0	0	0	0	0	0	0	2.8	0	0	0	0	0
Cum Day	0	0	0	0	0	0	0	0	1.75	3.1	4.2	5.4	6.6	6.6	8.35	9	9	10.8	12.5	13.8	13.8	15
Cum Night	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cum SIM	0	0	1.4	2.8	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	8.4	8.4	8.4	8.4	8.4	8.4
Short Day	0	0	0	0	0	0	0	1	0.25	0	0	0	0	1.2	0.65	0	1.2	0.65	0.1	0	1.2	0
Short Night	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Short SIM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2.8	0	0	0	0	0	0

Phase	Phase II: Instrument/BCS															
Training Day	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147
Day Flight Hour						1	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Night Flight Hour																
SIM Hours	1.4	2.8	2.8	2.8	2.8											
Cum Day	15	15	15	15	15	16	17.2	18.4	19.6	20.8	22	23.2	24.4	25.6	26.8	28
Cum Night	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cum SIM	9.8	12.6	15.4	18.2	21	21	21	21	21	21	21	21	21	21	21	21
Weather	1	0	0	0	0	1	0	0	1	1	1	1	1	1	1	0
Max Flight Hours	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75

Actual Hours	Phase II: Instrument/BCS															
Day Flight Hour	0	0	0	0	0	1	0	0	1.75	1.75	1.75	1.75	1.4	1.2	1.2	0
Night Flight Hour																
SIM Hours	1.4	2.8	2.8	2.8	2.8	0	0	0	0	0	0	0	0	0	0	0
Cum Day	15	15	15	15	15	16	16	16	17.8	19.5	21.3	23	24.4	25.6	26.8	26.8
Cum Night	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cum SIM	9.8	12.6	15.4	18.2	21	21	21	21	21	21	21	21	21	21	21	21
Short Day	0	0	0	0	0	0	1.2	2.4	1.85	1.3	0.75	0.2	0	0	0	1.2
Short Night	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Short SIM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Phase	Phase III: Stage I: Day Systems																	
Training Day	148	149	150	151	152	153	B2	154	155	156	157	157	159	160	161	162	163	164	B3
Day Flight Hour		1	1	1	1	1		1	1	1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	
Night Flight Hour																			
SIM Hours	2.8																		
Cum Day	28	29	30	31	32	33	33	34	35	36	37.1	38.2	39.3	40.4	41.5	42.6	43.7	44.8	44.8
Cum Night	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cum SIM	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8
Weather	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1
Max Flight Hours	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75

Actual Hours	Phase III: Stage I: Day Systems																	
Day Flight Hour	1.2	0	1.75	1.25	1	0	1	0	1.75	1.25	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	0
Night Flight Hour																			
SIM Hours	0	2.8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cum Day	28	28	29.8	31	32	32	33	33	34.8	36	37.1	38.2	39.3	40.4	41.5	42.6	43.7	44.8	44.8
Cum Night	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cum SIM	21	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8
Short Day	0	1	0.25	0	0	1	0	1	0.25	0	0	0	0	0	0	0	0	0	0
Short Night	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Short SIM	2.8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Phase	Phase III: Stage II: Night/Night Vision Systems																Phase III: Stage III: NVG				
Training Day	165	166	167	168	168	170	171	172	173	174	175	176	177	178	179	B4	180	181	182	183	184
Day Flight Hour																					
Night Flight Hour		1	1.2	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.4		1.2	1.2	1.2	1.2	1.2
SIM Hours																					
Cum Day	44.8	44.8	44.8	44.8	44.8	44.8	44.8	44.8	44.8	44.8	44.8	44.8	44.8	44.8	44.8	44.8	44.8	44.8	44.8	44.8	44.8
Cum Night	0	1	2.2	3.3	4.4	5.5	6.6	7.7	8.8	9.9	11	12.1	13.2	14.3	15.7	15.7	16.9	18.1	19.3	20.5	21.7
Cum SIM	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8
Weather	0	1	1	1	1	1	1	1	1	0	0	1	1	1	0	0	1	1	1	1	1
Max Flight Hours	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75
Actual Hours	Phase III: Stage II: Night/Night Vision Systems																Phase III: Stage III: NVG				
Day Flight Hour	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Night Flight Hour	0	1	1.2	1.1	1.1	1.1	1.1	1.1	1.1	0	0	1.75	1.75	1.75	0	0	1.75	1.75	1.75	1.2	1.2
SIM Hours	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cum Day	44.8	44.8	44.8	44.8	44.8	44.8	44.8	44.8	44.8	44.8	44.8	44.8	44.8	44.8	44.8	44.8	44.8	44.8	44.8	44.8	44.8
Cum Night	0	1	2.2	3.3	4.4	5.5	6.6	7.7	8.8	8.8	8.8	10.6	12.3	14.1	14.1	14.1	15.8	17.6	19.3	20.5	21.7
Cum SIM	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8
Short Day	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Short Night	0	0	0	0	0	0	0	0	0	1.1	2.2	1.55	0.9	0.25	1.65	1.65	1.1	0.55	0	0	0
Short SIM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Phase	Phase IV: Gunnery																							
Training Day	185	186	187	188	189	190	191	192	193	194	195	196	197	198	199	B5	200	201	202	203	204	205	206	207
Day Flight Hour							1	1	1.1	1.1	1.1	1.1	1.1	1.1	1.1								1.1	
Night Flight Hour																	1.1	1.1	1.1	1.1	1.1	1.1		
SIM Hours		2.8	2.8	2.8	2.8	2.8																		2.8
Cum Day	44.8	44.8	44.8	44.8	44.8	44.8	45.8	46.8	47.9	49	50.1	51.2	52.3	53.4	54.5	54.5	54.5	54.5	54.5	54.5	54.5	54.5	55.6	55.6
Cum Night	21.7	21.7	21.7	21.7	21.7	21.7	21.7	21.7	21.7	21.7	21.7	21.7	21.7	21.7	21.7	21.7	22.8	23.9	25	26.1	27.2	28.3	28.3	28.3
Cum SIM	23.8	26.6	29.4	32.2	35	37.8	37.8	37.8	37.8	37.8	37.8	37.8	37.8	37.8	37.8	37.8	37.8	37.8	37.8	37.8	37.8	37.8	37.8	40.6
Weather	1	1	0	1	1	0	1	0	1	0	1	1	0	1	1	1	1	1	1	0	1	1	1	1
Max Flight Hours	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75
Actual Hours	Phase IV: Gunnery																							
Day Flight Hour	0	0	0	0	0	0	1	0	1.75	0	1.75	1.75	0	1.75	1.7	0	0	0	0	0	0	0	1.1	0
Night Flight Hour	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.1	1.1	1.1	0	1.75	1.55	0	0
SIM Hours	0	2.8	2.8	2.8	2.8	2.8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2.8
Cum Day	44.8	44.8	44.8	44.8	44.8	44.8	45.8	45.8	47.6	47.6	49.3	51.1	51.1	52.8	54.5	54.5	54.5	54.5	54.5	54.5	54.5	54.5	55.6	55.6
Cum Night	21.7	21.7	21.7	21.7	21.7	21.7	21.7	21.7	21.7	21.7	21.7	21.7	21.7	21.7	21.7	21.7	22.8	23.9	25	25	26.8	28.3	28.3	28.3
Cum SIM	23.8	26.6	29.4	32.2	35	37.8	37.8	37.8	37.8	37.8	37.8	37.8	37.8	37.8	37.8	37.8	37.8	37.8	37.8	37.8	37.8	37.8	37.8	40.6
Short Day	0	0	0	0	0	0	0	1	0.35	1.45	0.8	0.15	1.25	0.6	0	0	0	0	0	0	0	0	0	0
Short Night	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.1	0.45	0	0	0
Short SIM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Phase	Phase V: ACS								Class Buffer			
Training Day	208	209	210	211	212	213	214	215	B6	B7	B8	B8
Day Flight Hour			1.5				1.25	1.25				
Night Flight Hour				1.5								
SIM Hours	2.8	2.8										
Cum Day	55.6	55.6	57.1	57.1	57.1	57.1	58.4	59.6	59.6	59.6	59.6	59.6
Cum Night	28.3	28.3	28.3	29.8	29.8	29.8	29.8	29.8	29.8	29.8	29.8	29.8
Cum SIM	43.4	46.2	46.2	46.2	46.2	46.2	46.2	46.2	46.2	46.2	46.2	46.2
Weather	0	0	0	1	1	1	1	1	1	1	1	1
Max Flight Hours	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75
Actual Hours	Phase V: ACS								Class Buffer			
Day Flight Hour	0	0	0	1.5	0	0	1.25	1.25	0	0	0	0
Night Flight Hour	0	0	0	0	1.5	0	0	0	0	0	0	0
SIM Hours	2.8	2.8	0	0	0	0	0	0	0	0	0	0
Cum Day	55.6	55.6	55.6	57.1	57.1	57.1	58.4	59.6	59.6	59.6	59.6	59.6
Cum Night	28.3	28.3	28.3	28.3	29.8	29.8	29.8	29.8	29.8	29.8	29.8	29.8
Cum SIM	43.4	46.2	46.2	46.2	46.2	46.2	46.2	46.2	46.2	46.2	46.2	46.2
Short Day	0	0	1.5	0	0	0	0	0	0	0	0	0
Short Night	0	0	0	1.5	0	0	0	0	0	0	0	0
Short SIM	0	0	0	0	0	0	0	0	0	0	0	0