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THESIS

A SYSTEMS ENGINEERING BASED ANALYSIS OF THE MH-60R FLEET REPLACEMENT SQUADRON CATEGORY I SYLLABUS AS A SCHEDULE

by

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September 2021

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ABSTRACT

The fleet replacement squadron (FRS) syllabus is analyzed using a systems-engineering-based analysis. A review of the daily flight schedules at the Helicopter Maritime Strike FRS in San Diego is conducted, and cancellation data is compiled to incorporate into the syllabus model. Concurrent with the schedule analysis, a determination of previously unaccounted for cancellation factors and associated impact to on-time syllabus completion is conducted. The syllabus is modeled as a schedule and presented in the form of a functional flow block diagram (FFBD). The FFBD allows for visual and computational review of the syllabus as a project schedule. Then, using Innoslate, a systems engineering modeling tool combining Systems Modeling Language (SysML) and discrete simulations, the Category I FRP syllabus at the FRS is analyzed as a schedule. Utilizing preplanned, in addition to observed, cancellation rates for syllabus events, results indicate that the current timeline is overly optimistic, probabilistically requiring more time to complete the training syllabus than currently allotted.

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LIST OF ACRONYMS AND ABBREVIATIONS

AHM	aircraft handling maneuvers
API	Aviation Preflight Indoctrination
ASW	anti-submarine warfare
ATO	airborne tactical officer
CCMM	Course Curriculum Model Manager
CNAF	Commander Naval Air Forces
CNATRA	Chief of Naval Air Training
CY	calendar year
DLQ	deck landing qualification
DOD	Department of Defense
ET	extra training
ETA	estimated time of arrival
ETD	estimated time of departure
FAM	familiarization [flight]
FDPLN	flight deck landing pattern night
FFBD	functional flow block diagram
FOD	foreign object debris
FRAC	fleet replacement aircrewman
FRP	fleet replacement pilot
FRS	fleet replacement squadron
HIGS	Helicopter Instrument Ground School
HITS	Helicopter Instrument Training School
HSM	Helicopter Maritime Strike
IFS	Introductory Flight Screening
MCS	master course schedule
NAE	Naval Aviation Enterprise
NATOPS	Naval Air Training Operating Procedures Standardization
NIFE	Naval Introductory Flight Evaluation
NVD	night vision device
OFT	operational flight trainer

OPNAV	Chief of Naval Operations
ORM	operational risk management
SACT	surface-to-air countertactics
SAR	search and rescue
SBFF	Shipboard Firefighting
SOD	signal of difficulty
SUW	surface warfare
T/M/S	type/model/series
TAC	tactical [flight]
TMR	total mission requirement
TOFT	tactical operational flight trainer
TTT	time-to-train
WTT	weapons and tactics trainer

EXECUTIVE SUMMARY

The Fleet Replacement Squadron (FRS) is the final milestone in the progression of a prospective naval aviator entering a fleet squadron as a fleet replacement pilot (FRP). The FRS provides specific training on flight and tactics for the platform that the naval aviator will fly in the fleet. As such, the FRS can be viewed as an acquisition system, where the asset is the FRP. The specific training that the FRP receives is a carefully orchestrated syllabus of instruction, overseen by the Chief of Naval Air Forces.

Helicopter Maritime Strike Squadron FOUR ONE (HSM-41), based in San Diego, is one such Fleet Replacement Squadron, for the MH-60R Seahawk helicopter, and it is the Model Manager of the same platform. The squadron’s role in the Naval Aviation Enterprise is train newly winged naval aviators to operate and employ the MH-60R helicopter through computer-aided instruction, instructor-led classroom events, simulator training, and flight events. The goal is to deliver the asset, a pilot qualified in model, to fleet squadrons fully trained and on time.

This thesis focuses on the conduct of a systems engineering analysis of the FRS syllabus as a schedule. To complete this analysis, a functional flow block diagram (FFBD), representative of the syllabus, was generated and a thorough review of available event completion data was conducted.

Utilizing the flight and simulator events as nodes, the FFBD was constructed in Innoslate using the Action diagram framework. The model was derived from syllabus flow as directed by the Category I Syllabus Daily Planner and the CAT I Pre-Requisite Guide, both products generated by the Course Curriculum Model Manager (CCMM) and the Curriculum Officer at HSM-40, the two officers assigned to maintain and revise/update the syllabus of instruction.

The phases were decomposed into individual events, and the individual events were further decomposed to implement probabilistic loop gates to account for the cancellation factor percentages determined in the data review. Each cancellation factor results in the loss of at least one training day per activation, with student signal of difficulty (SOD) being the exception. If a student receives a SOD for an event, there is a minimum loss of two days of training, one for the originally scheduled event and one for the next day where the FRP's syllabus progression and aptitude is reviewed by the Standardization Officer and Training Department Head before the FRP resumes training.

To provide the data to feed into the model, a thorough review of a full year of flight schedules from HSM-41, over 7000 flight and simulator events, yielded extensive information regarding event cancellations and delays. Greater than 10% of all events were lost due to maintenance issues with the aircraft or simulator, student or instructor opting out of flight due to an operational risk management (ORM) factor (i.e., illness, crew rest limitations, other stressors), SOD, or weather cancellation (aircraft only).

Discrete simulations (100 total) of the FRS schedule were conducted in Innoslate, and the cancellation data was aggregated to provide the opportunity for a numerically driven review of schedule performance against currently allotted cancellation figures. The data (mean of 8.2 days, minimum of 2.0 days, maximum of 17.0 days) illustrated that the current cancellation adjustment figure of 8.0 days is statistically unsatisfactory, with greater than 50% of syllabus simulations taking longer to complete. This data also corroborates the assumption that a systems engineering-based analysis of the CAT I FRP syllabus as a schedule would yield benefits to the stakeholder in the form of informed risk-based decision-making. The processes currently in place are likely insufficient at consistently predicting schedule losses as a function of unplanned cancellations. By adding just three days to the current cancellation adjustment figure of 8.0 days, for a new cancellation adjustment of 11.0 days, the probability for completion within the requisite timeline increases to greater than 80%.

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This undertaking would have been impossible without the support and understanding from an exceptional human being, my wife Jillian. For countless hours and all-nighters throughout the program, she remained a steadfast source of patience, understanding, and motivation. My gratitude will never be enough, but, from the bottom of my heart, thank you.

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I. INTRODUCTION

A. BACKGROUND

The naval aviation training program is managed and implemented by the Chief of Naval Air Training (CNATRA). Once selected as a student naval aviator (SNA), the first step in the training pipeline, depicted in Figure 1, is Naval Introductory Flight Evaluation (NIFE), a program implemented in 2020 that combines Aviation Preflight Indoctrination (API) and Introductory Flight Screening (IFS) into a single program (Owens 2020). The training begins on the ground, with a focus on academic topics and water survival training. SNA's receive classroom instruction on aviation weather, aircraft engines, aerodynamics, navigation, and flight rules and regulations. Following ground training, the SNAs begin flight training in a Cessna 172, or similar aircraft. This phase focuses on flight basics and introduces radio procedures for coordination with air traffic controllers and other aircraft. The intent of NIFE is to introduce fleet training practices to the SNA early in their careers, minimizing the potential for training delays due to lack of student preparation or knowledge of expectations.

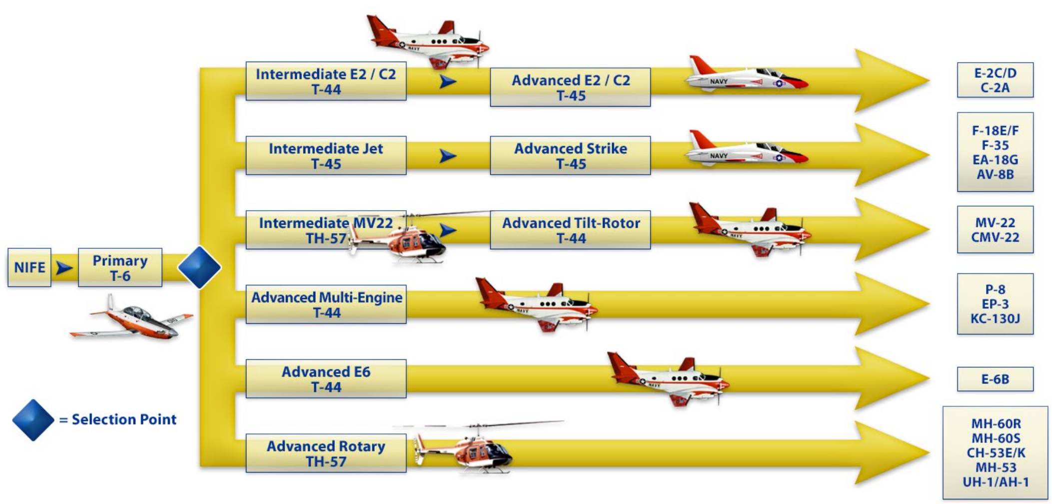

Figure 1. Aviation Training Pipeline. Source: Chief of Naval Air Training (2021).

After NIFE, the SNA begins Primary flight training in the T-6B Texan II, a single-engine, fixed-wing training aircraft. The intent of Primary is to build upon the basic flight operations learned in NIFE and screen the SNA for suitability in follow-on aircraft assignments. As depicted in Figure 1, following the completion of Primary, the training pipeline diverges and the SNA is selected for a specific training path based on the requests of the SNA and balanced with the needs of the U.S. Navy. The following Intermediate/ Advanced training pipeline delivers instruction that is tailored to the type of aircraft the SNA will fly in the fleet. For example, future helicopter pilots receive Advanced flight training in the TH-57B/C Sea Ranger. Once the SNA completes all phases of Primary, Intermediate (as required), and Advanced flight training, he is designated as a naval aviator, receives his "wings of gold," and proceeds to the next phase of training: The Fleet Replacement Squadron (FRS).

The primary goal of the fleet replacement squadron is to train newly winged and designated naval aviators in becoming tactically proficient Fleet Replacement Pilots (FRP) and transition them to deployable squadrons. It is the final step in the training pipeline for all U.S. naval aviators. An FRP is a pilot enrolled in an FRS syllabus in a student status. Each fleet aircraft operates a separate FRS to train and prepare FRPs to fly that aircraft in a fleet squadron. Each FRS is also the Model Manager for the respective Type/Model/ Series (T/M/S), meaning all changes to governing publications (i.e., Naval Air Training Operating Procedures Standardization (NATOPS) Flight Manual) are submitted to, and reviewed by, the FRS. In the case where the T/M/S has more than one FRS (i.e., HSM-40 and HSM-41 are both MH-60R Fleet Replacement Squadrons), one of the squadrons is designated as the Model Manager.

In the case of a newly winged aviator, not previously qualified in the model of aircraft being trained in, the Category I syllabus applies. If the FRP was previously qualified in model (i.e., H-60), there are many different syllabi that may apply:

- Category IIC – syllabus designed for pilots that are current in another T/ M/S of the H-60 but are not qualified in the MH-60R (i.e., currently qualified in the SH-60B).

- Category IINC – syllabus designed for pilots that were previously qualified in another T/M/S but are no longer current (i.e., lack of a current NATOPS check flight and/or greater than a year out of the aircraft).
- Category III – syllabus designed for fleet returnees, previously qualified in the MH-60R, but greater than 18 months out of the cockpit. Usually reserved for department heads returning to fleet squadrons following a disassociated sea tour (non-flying) or prospective commanding officers and executive officers of fleet squadrons returning from a joint or staff tour (non-flying).
- Category IV – syllabus similar to the CAT III syllabus, but for the small margin of returnees that are greater than 12 months, but less than 18 months, out of the cockpit.
- Category V – a custom syllabus comprised of existing syllabus events, developed by the Curriculum Officer, and approved by the FRS commanding officer, for unique circumstances (i.e., Carrier Air Wing Commander desires to have some instruction in an aircraft in his air wing that he is not currently qualified to fly in).

All syllabi at the FRS are designed to act as a roadmap to complete a primary metafunction of the FRS as it acts as a system. An IDEF0 (Integrated DEFinition) is a depiction of function or sub-function of a system. The model can be further decomposed or elevated as required to capture the desired scope or to present necessary information to stakeholders and decision-makers. The diagram details the inputs, controls, and mechanisms, and outputs of the specified function. There are other IDEF models that can be used to illustrate the functions and processes of a system, but were determined by the author to be unnecessary for the analysis performed in this thesis and other methods were used instead.

The HSM FRS metafunction, depicted as an IDEF0, is illustrated in Figure 2. Inputs for the model include: winged aviators and unscheduled delays (incomplete events, maintenance, ORM signals of difficulty, and weather). Mechanisms include the physical constructs necessary to complete the metafunction. For the HSM FRS metafunction, these include the airfield or air station from which the squadron operates, the aircraft, simulator, and classrooms necessary to facilitate instruction, and the instructors and maintenance personnel required to complete the syllabus events and maintain the facilities and aircraft. Controls govern how the metafunction is completed. In this case, the mission of the MH-60R and manning requirements are pulled from the National Security Strategy, National Military Strategy, and the determined FRP quota for the fiscal year. The FRS syllabus and the NATOPS manual determine a large portion of the training conducted, and CNAFINST 1500.12 governs the construction of FRS syllabi as well as its annual review. Therefore, it still acts as a control to the metafunction while also governing the creation of another control at the same functional level. The primary output is a trained fleet replacement pilot, ready to commence operations in a fleet squadron.

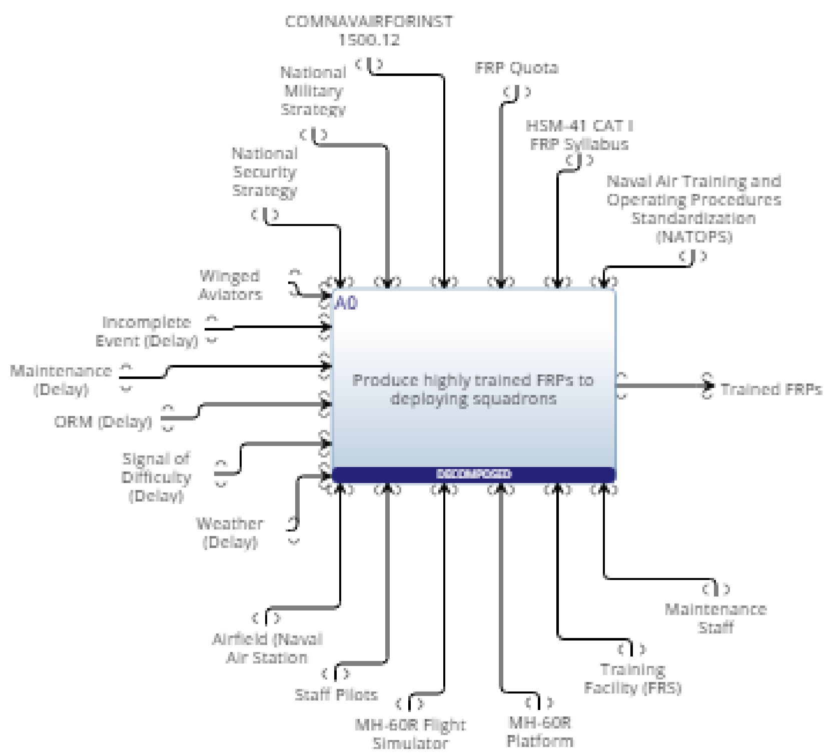

Figure 2. HSM FRS Metafunction

Using the information garnered after a review of the FRS as a system and applying the information in the creation of the model in Figure 2, the decision was made to focus on the syllabus. All the listed mechanisms are indispensable and not subject to change that could substantiate system improvement. The same can be said for the inputs, as none listed can be eliminated. The controls and governing instructions for strategic guidance are difficult to revise at this level except the FRS syllabus. The syllabus is required by instruction to be reviewed, at a minimum, annually and revised as necessary (Commander Naval Air Forces 2007). Implementation of the recommendations presented in this thesis to CNAF 1500.12, or specifically to the HSM FRS syllabus, could provide the stakeholder with a more accurate measure of this system's performance and efficiency.

The syllabus is a schedule, and it acts as the roadmap that the FRS uses to produce the asset, the trained FRP. This schedule is built into an architectural model, more specifically, a functional flow block diagram, and the scope of the model is limited to the aforementioned phases of training in the syllabus with each phase including a series of flight, simulator, and classroom-based sub-events that comprise the phase.

This thesis focuses on the Category I syllabus, the transition from newly winged naval aviator to trained FRP in the MH-60R. While at Helicopter Maritime Strike Squadron 40 (HSM-41) or Helicopter Maritime Strike Squadron 41 (HSM-41, the MH-60R Model Manager based on NAS North Island in San Diego), each winged aviator undergoes extensive training in the MH-60R in order to be designated as a Pilot Qualified in Model in accordance with CNAFINST 3710.7. This is accomplished through training conducted in phases: the pilot phase, the Deck Landing and Qualification (DLQ) phase, and the Airborne Tactical Officer (ATO) phase (further broken down into the Surface Warfare [SUW] and Antisubmarine Warfare [ASW] phases). Each phase is comprised of numerous classroom, simulator, and flight events, organized in gradually more complicated phases, to teach new concepts and tactics. Satisfactory performance in graded syllabus events certifies completion and graduation from this phase of training.

B. PROBLEM DEFINITION

According to Blanchard and Fabrycki (2014, 57), "the systems engineering process commences with the identification of a 'want' or 'desire' for something based on a 'real' deficiency." The decision to undertake the effort of this thesis was based on the desire to mathematically determine whether there is, or is not, a real deficiency with the system schedule. From personal experience as an instructor pilot at the FRS, I lost many scheduled training events due to various cancellation factors. This often required the efforts of multiple schedule writers and training planners to reschedule events and sorties on the current or next day's schedule to accommodate the integration of a lost event. Depending on the time of day for the cancellation, the result was the loss of the next day's event as well if one event was a prerequisite for the next one. Subjective observation illustrated that most events were lost due to maintenance issues with the aircraft, and it was the opinion of the author that the current metrics are deficient in planning for losses due to cancellation. Therefore, the syllabus is an insufficiently developed schedule that requires further effort to adequately plan for FRP time-to-train (TTT).

Time-to-train for FRPs is a continuously evaluated metric at the FRS. It is reported on a regular basis to CNAF. Outliers, FRPs that are trending below glideslope to finish on time, are closely monitored and often given priority scheduling to bring back on track. The current allotted TTT for the FY16 version 2 Category I FRP syllabus is 38.3 calendar weeks, approximately nine months with optimal scheduling of each student being five days per week, every week, while attached to the squadron. This accounts for the total number of training days in the syllabus, 164 days for the Category I FRP, and is corrected for maintenance (aircraft and simulator events) and weather (aircraft events only) delays. As illustrated in Table 1 the total number of flight sorties and simulator events in the syllabus are multiplied by corresponding correction factors.

Table 1. Category I FRP TTT Calculator. Adapted from CNAFINST 1500.12 (2007).

MH-60R FRP CAT I TTT			
Part IV			
# of Sorties	30		
# Simulators	55		
MCS Training Days			
# Days	164		
Maintenance Cancellation factor			10.0%
Weather Loss Factor (PPF Value)			4.8%
Simulator Cancellation Factor			5.0%
Flight Variances			
Sorties	Factor		Days
30	10.0%		3.0
30	4.8%		1.4
		Flight Total	5.0
Simulators Variances			
Events	Factor		
55	5%		2.8
		Flight & Simulator Total	8.0
Maint/Weather/SIM			8
Training Days			164
Total Training Days Adjusted			172
T-Day to P-Day Conversion			
T-Days	P-Days	P-Weeks	
172	266	38.0	
Part V			
0.0	INDOC		
0.4	HITS		
0.2	SBFF		
38.0	Weeks Core Course		
38.6	Total Pipeline/PPF Time to Train		

The Maintenance Cancellation factor, applied to flight events only, is determined by Commander Naval Air Forces (CNAF). It is specific to the T/M/S. The Weather Loss Factor, flight events only, is training site-specific and is determined by Chief of Naval Operations (OPNAV) on a three-year historical average. The Simulator Cancellation Factor is applied to simulators and is based on contracted availability (Commander Naval Air Forces 2007).

These factors are applied to the flight and simulator sortie totals from the Master Course Schedule (MCS) to generate a new Training Days (T-Days) figure. An additional flexibility factor of 10% is applied against the T-Days to account for holidays, squadron safety standdowns, command inspections, changes of command, and similar events. The final correction is to multiply this number by 1.4 to determine total Pipeline Days (P-Days) and then dividing by seven. This accounts for Saturday and Sunday (non-training days) before dividing the total number of days by seven to determine Pipeline Weeks (P-Weeks) (Commander Naval Air Forces 2007). In Table 1, Helicopter Instrument Training School (HITS), now referred to as Helicopter Instrument Ground School (HIGS), and Shipboard Firefighting (SBFF), are not part of the core course of instruction, but are included in total pipeline length as they are required before the FRP completes the syllabus and reports to his fleet squadron.

As illustrated by the level of effort implemented to determine the maximum number of days lost during the execution of the syllabus due to unplanned circumstances, it is possible to interpret that a high level of effort was implemented to plan for event losses, but the following section illustrates where additional focus could prove worthwhile.

C. RESEARCH QUESTIONS

This thesis aims to provide insight and answers to the following questions:

- Can a systems engineering analysis identify shortcomings of the current syllabus as a schedule for the fleet replacement squadron system?
- Are all causes for cancellation accounted for in the syllabus planning process?
- Are the requisite completion timeframes for Category I FRP graduation rates to fleet squadrons consistently within acceptable tolerances?
- Are proposed cancellation rates indicative of observed cancellation rates?

D. BENEFIT OF STUDY

By viewing the syllabus at the FRS as a system, specifically as a schedule with milestones and a firm delivery date of a DOD asset, it becomes possible, with additional data, to accurately plan for the delivery of date asset to the fleet.

Due to the nature of the naval aviator and naval flight officer training pipelines, it can take upwards of three years before the trained pilot is checking into his fleet squadron. This means that manning requirements and trained aviator throughput must be forecasted as accurately as possible. This thesis focuses on a portion of the latter half of that forecast requirement.

E. THESIS ORGANIZATION

Chapter I introduced the NAE training process, including a detailed explanation of the tasks and purpose of a fleet replacement squadron, specifically the MH-60R FRS. Additionally, the problem at the focus of this thesis is defined and research questions tailored to target a solution to this potential problem have been articulated.

Chapter II provides an applied literature review, referencing source material that molded the methodologies used to approach the problem at hand as well as shortcomings of the modeling environment selected for use.

Chapter III provides an overview of the development of the model and the subsequent analysis to be undertaken. This includes a discussion on the driving factors behind the decision to model and how the model itself was created. As the data required to incorporate probabilistic cancellation factors was not aggregated in a single data bank, the chapter will also illustrate the efforts taken by the author to incorporate accurate and useful data in the model simulations.

Chapter IV provides the presentation of data and results from the discrete simulations conducted in Innoslate. The discrete simulations (100 total) each provide exceptional data including number of days lost due to a cancellation factor as well as the affected event and cancellation reason.

The conclusion of this thesis is provided in Chapter V along with recommendations for schedule improvement and areas for further research. Anecdotal observations, from recollected experiences and subjective analysis of the results are also offered.

II. LITERATURE REVIEW

This thesis uses multiple systems engineering tools and processes to analyze the CAT I syllabus as a schedule. For the purposes of this analysis, sufficient applicable data must be available, compiled, and organized into a useful product. On each daily flight schedule, the status of event completion or reason(s) for cancellation is cataloged. Each annotation acts as a data point for the approximately 30–50 events per day. This data was extracted from 12 months of completed flight schedules and compiled into a single location for analytical review. The source data, combined with a method of testing or simulation, yields metrics that can be utilized for analysis and comparison. The analysis efforts can then be employed as a catalyst of change and system improvement.

A. DATA COLLECTION AND ANALYSIS

Hart (2015) uses the term "data-rich environment" in her presentation on model-based systems engineering and SysML. The term refers to a situation where the volume of available data to interpret and plan from is cumbersome. In text and document form, the data is difficult to fully comprehend or effect meaningful change within the system. Therefore, the data must be aggregated into useable form as a function of analysis. Kerzner (2013) lists many methods of analysis in his book, *Project Management: A Systems Approach to Planning, Scheduling, and Controlling*, including Assumption analysis, Metrics, and Schedule Analysis. The CAT I syllabus already exists as a schedule, with significant data available for aggregation and exploitation for study. Part of that schedule analysis includes the evaluation of the baseline inputs to the schedule (Kerzner 2013). In the case of the FRS syllabus, the baseline inputs are the current syllabus events, requisite completion timelines, and the currently applied cancellation factors. If the baseline inputs are inadequate for planning purposes, updates must be made to ensure proper controls are put in place to correct for noted deficiencies. A thorough review and compilation of available data from a system, when compared with metrics currently employed within the system, will reveal a delta that must be minimized to guarantee efficient system performance.

B. MODELING

A model is defined as "an abstracted representation of some aspect of a system" (Maier and Rechtin 2009). It can be used to represent a system that is already functioning, or simulate the processes of a system that is not yet operational (Blanchard and Fabrycky 2014). One of the many benefits of modeling is to characterize an existing system with the goal to improve its function or design (Friedenthal, Dori, and Mordecai 2021). This process transfers the data that already exists in textual form into a more easily absorbed visual format, such as, in the case of this thesis, a functional flow block diagram (FFBD).

The more closely the design of a model and its behavior matches its parent system, the more effective it is fulfilling crucial roles in systems engineering and architecting. According to Maier and Rechtin (2009), models allow for clear communication between client, users, and builders. In a "data-rich environment," the utilization of models reduces efforts to inform stakeholders, evaluate system performance, and effectively plan for future work (Hart 2015). This process transfers the textual data into a more easily understood graphical representation of the same information, thereby reducing the effort necessary to convey that information.

In the case of the FRS syllabus, the client is CNAF, the primary users are the FRPs and instructor pilots, and the primary builder is the Course Curriculum Model Manager. A model also allows for the determination of performance prediction of the system using simulations (Maier and Rechtin 2009). Simulations afford the opportunity to quickly generate representative data without exercising the system and its functions in real-time (i.e., a single simulation of FRP syllabus execution takes seconds to simulate v. months for the FRP to complete in real-time), allowing for more analysis of system performance without the respective increase in cost (Hart 2015).

An FFBD is used to show the movement and progression of assets within a system. The asset can be anything from data to physical elements (Kerzner 2013). The blocks can be used to represent events or actions hierarchically, where each level of action can be decomposed to baser levels. The blocks are connected via lines, illustrating the movement of data and/or elements. This presentation delivers information to key stakeholders and decision-makers in a clearer demonstration of syllabus flow when compared to line-items on a calendar, allowing stakeholders to more easily determine impacts of decisions to change pre-requisite requirements, number of events to plan for, and the influence that various obstacles have on the success of the system (Hart 2015).

In the case of a FFBD model at the focus of this thesis, the aspect of the system being fabricated into an abstracted representation is representative of an event flow network, where the behavior of the system aspect is defined by a network of functions that illustrate the flow of information (Maier and Rechtin 2009). The FFBDs in this thesis are modeled after the syllabus flow as determined by the daily planner and pre-requisite guide.

The potential benefit to this is reducing cost. With sufficient model fidelity and data implementation, experimental investigation during simulation of system decision points can become automated, further decreasing cost to operate and improving system efficiency (Blanchard and Fabrycky 2014; Hart 2015). In the case of the FRS, while monetary cost is also a factor, the "cost" of other-than-on-time completion of the syllabus is the delayed arrival of an FRP to a fleet squadron. This has the potential to degrade squadron readiness in the form of insufficient number of crews on board or critically necessary pilots for deployment.

C. RISK MANAGEMENT AND MONTE CARLO SIMULATION

"Risk is a measure of the probability and consequence of not achieving a defined project goal," meaning that when determining factors that could introduce schedule creep, the likelihood of introduction must be assessed alongside the impact of the following aftereffects (Kerzner 2013, 873). If the likelihood or the impact increases, the risk increases. Risk management is at the discretion of the primary stakeholders and can be completed through a defined process. Kerzner provides the following list of tasks to complete during the risk management process: 1. Identify Risks, 2. Perform Risk Analysis, 3. Plan Risk Response, 4. Monitor and Control Risk (2013). This is very similar to the five-step process that the U.S. Navy uses regarding operational risk management: 1. Identify Hazards, 2. Assess Hazards, 3. Make Risk Decisions, 4. Implement Controls, 5. Supervise. The first step is to identify all factors that hold the system at risk of inefficient operation.

Once all factors have been identified, determine the influence the factors have on the system. Whether the factors can or cannot be mitigated, determine the necessary response(s) to ensure continued system operation. After this, continue to monitor and supervise the system, implementing new controls as necessary.

An effective means of managing risk is to conduct quantitative risk analysis of a system. The requirements to do it effectively "include developing and accurate model structure and incorporating accurate probability information" (Kerzner 2013, 903). This analysis method incorporates the SE processes discussed earlier into a quantifiable and repeatable process of determining the probability of meeting schedule objectives in the desired timeframe. Subjecting the model and probability data to numerous simulations allows for the development of probabilistic distributions of data, visual representations of system risk. The higher the number of iterations run in each simulation, the more accurate the probability data, assuming the model is of sufficient quality and the incorporated probabilistic data is accurate (Kerzner 2013). This is process is called a Monte Carlo analysis. With plenty of simulation iterations, a comparative analysis of incorporated risks can identify the hazards that hold the system most at risk of failing to meet milestones or asset delivery timeframes.

D. MONTE CARLO VS. DISCRETE SIMULATION

When determining the modeling environment for this thesis, the author elected to use Innoslate based on prior experience with the software, the simplicity of the user interface, and the ability for the software to generate graphical models as well as run simulations on the same models. Due to the limitations of the Innoslate modeling software, events depicted on parallel pathways in the FFBD (Action) model are performed simultaneously (Innoslate 2021). The addition of a lone Asset or Actor does not change the simulation process. In a normal FFBD, with a lone asset required to complete all events before proceeding past the parallel path, the simulation would ideally choose to execute one event before completing another in a parallel path. Both events would be complete, but sequentially, for, in this case, the FRP can only complete one event per day. In the Innoslate Action models, the simulation does not restrict the simulation in this manner, and actions/

events depicted on parallel paths can be completed simultaneously, artificially decreasing the length of time it takes to complete the events in the model.

Ideally, Monte Carlo simulations of the model would be conducted to provide a higher degree of accuracy to the findings presented in this thesis; however, following a Monte Carlo simulation, there is no way to determine how many events may have been completed in parallel with another event. Discrete simulations in the same software produce more data that is specific to the simulation, allowing the attribution of cancellation factors to the days lost in the simulation. Therefore, to properly account for each day lost to a cancellation factor, discrete simulations are required when utilizing FFBD models in Innoslate.

E. SUMMARY

This chapter provided a summary of current literature that supports an analysis such as the one presented in this thesis. The application of current data into a representative model that is repeatedly subjected to simulation can yield data that allows for probabilistic risk analysis by stakeholders and decision-makers. When this analysis is applied to the syllabus, it has the potential to minimize the likelihood of missing the on-time completion of all syllabus events, thereby ensuring the respective FRP arrives to his fleet squadron on time and fully trained. The next chapter covers the process undertaken to develop the syllabus model and conduct simulations with incorporated cancellation data.

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III. MODEL DEVELOPMENT AND SIMULATION

A. METHODOLOGY OVERVIEW

1. Why Model?

The MH-60R FRS has existed as a functional system with the syllabus as the schedule since 2005. This syllabus in use was adapted from the syllabus that was already in place for the SH-60B, the predecessor to the MH-60R. As the mission areas of the MH-60R SEAHAWK expand to fulfill DOD requirements and U.S. Navy mission areas and mission systems are upgraded with innovative technologies, the syllabus expands and adapts to these tactical and technological changes.

Modeling a system, or its components, provides numerous benefits and provides critical data to key stakeholders and decision-makers. The model illustrates the flow and progression of data as it progresses through the system. In the case of the syllabus, the model illustrates the schedule and the data is the FRP as he progresses from one event to the next through the entirety of the system. When probabilistic cancellation data is incorporated, the model becomes a valuable simulation and prediction tool. Data output can include event flow patterns, troublesome events in terms of cancellation, and days required to complete all schedule requirements.

As the FRS curriculum is based on training days scheduled in accordance with a calendar and established event flow, the syllabus comports as a simple framework of day-to-day events. Complexity infiltrates the system via external factors that are often difficult to completely account for. It is impossible to plan for all contingencies, but with a sufficiently detailed model of the system, it becomes easier to determine hurdles to success and potential controls to counteract those hurdles.

2. Keys to a Good Model

Determining the scope of a system model is crucial to the validity and reliability of a model and its associated data. What the model needs to do and what information it needs to provide and just as important as determining a measure of model effectiveness. The

FFBD models generated in support of this thesis illustrate the event flow for the multiple phases of the syllabus. The models only need to include the flight and simulator events as cancellations for classroom events are exceptionally rare and statistically irrelevant.

The FRS is representative of the "data-rich environment" that Hart refers to in her presentation on model-based systems engineering. There is data available for completion timeframes, cancellation metrics, and scheduling metrics as a comparison of desired progression (i.e., below/on/above glideslope for on-time completion). Before the efforts presented in this thesis, not all available data was being utilized to determine syllabus lengths as a function of cancellation factors. After determining all statistically relevant cancellation factors, the model generated in Innoslate could be configured in one of two ways. As each cancellation factor is mutually exclusive of the other, the total probability of cancellation for an event is equal to the sum of the individual probabilities. As illustrated below, the probabilities for events A, B, or C occurring are mutually exclusive, meaning that the probability of one event occurring has no impact on the probability of another event occurring. In other words, the probability of event A, event B, or event C occurring in a given instance is equal to the sum total of their individual probabilities.

$$P(A \text{ or } B \text{ or } C) = P(A) + P(B) + P(C)$$

Therefore, a model with the probabilities of all cancellation factors summed together would produce the same number of cancellations as a model with each factor integrated into the model independently. Unfortunately, simulations in the available software would prove incapable of attributing the days lost to a specific cancellation factor. Modeling with each factor implemented individually within the model affords the opportunity to analyze simulation data and accurately correlate lost days with the associated cancellation factor. The benefit to this method allows key stakeholders, CNAF and OPNAV, to determine specific suitable measures to correct specific deficiencies within the system.

B. CAT I SYLLABUS

The syllabus of instruction provides the framework through which the FRS system is executed. It is the roadmap and schedule that the system uses to produce the desired asset, the trained FRP, in the requisite amount of time. Meeting the time requirements for delivery of the trained FRP to fleet squadrons is of critical importance to maintaining manning requirements and unit readiness to deploy. Observed Time-to-Train is the primary metric for determining the on-time completion of syllabus requirements. The TTT for a Category I FRP is 268 days. Of those 268 days, 85 days are dedicated to flight or simulator events broken down into multiple event types: Familiarization (FAM) Flights, DLQ Flights, Tactical (TAC) Flights, WTT (Weapons and Tactics Trainer) Simulators, OFT (Operational Flight Trainer) Simulators, and TOFT (Tactical Operational Flight Trainer) Simulators.

1. Familiarization Flights

Familiarization flights are designed to introduce the FRP to the capabilities, limitations, and flight characteristics in a number of different environments: basic flight maneuvers conducted at the airfield, search and rescue (SAR) training overwater, flight in simulated and actual instrument conditions, vertical replenishment training, and flights at night both unaided and aided by night-vision devices (NVDs). In the Category I FRP syllabus, these events include: FAM 1-5 (basic flight maneuvers), FAM 6N (introduction to night flight in the MH-60R, unaided), FAM 7-8 (additional basic flight maneuvers), FAM 9X (pre-check ride), NATOPS X (basic flight checkride), SAR 1 (introduction to SAR), SAR 2N (introduction to night SAR), INST 1 (introduction to instrument flight and basic instrument maneuvers), INST 2N(instrument training conducted at night, aided or unaided), INST X (if conducted in the aircraft, CNAF-required annual checkride for instrument certification), DIP 1 (introduction to dip-to-dip pattern, a maneuver designed to efficiently employ the dipping sonar in an ASW scenario), NVD 1-3 (aided night flight, basic maneuvers and low level navigation), and FAM 10 (VERTREP and logistics).

2. Deck Landing Qualification Flights

The DLQ phase introduces the FRP to the shipboard environment through classroom training, simulator events, and flight events. The instruction provides the student with the requisite knowledge to fly an approach to a ship, land on the ship utilizing positional line-up aids and necessary calls, and take off and depart safely. The flights are Flight Deck Landing Pattern Night (FDLPN), DLQ 1, and DLQ 2. While three training days are specifically allotted to the flights associated with this phase, DLQ 1, daytime shipboard landings, and DLQ 2, nighttime shipboard landings, are often conducted sequentially on the same day.

3. Tactical Flights

TAC flights allow the FRP to exercise in the aircraft lessons learned in the simulator in addition to formation flights, low-level navigation, and landing at sites other than airfields. TAC 1 is an introduction to RADAR, electronic support measures (ESM), and the multi-spectral targeting system (MTS). TAC 2 is an introduction to tactical formation flight where two helicopters fly and maneuver in close proximity providing mutual support to each other and improving lethality in combat situations. TAC 3 is a flight flown at low altitude that allows the FRP to navigate using charts and distinctive ground checkpoints to arrive at a location to conduct approaches and landings to unprepared surfaces or confined landing zones. TAC 4 and 6 allow the FRP to practice SUW practices and tactics learned in the simulator, while TAC 7 and 8 allow the same for ASW. TAC 5 is dedicated to surface-to-air countertactics (SACT) and aircraft handling maneuvers (AHM), where the FRP learns methods to survive surface-to-air engagements and maneuvering characteristics of the airframe.

4. Weapons and Tactics Trainer

The WTT is a partial task trainer. Incapable of simulating flight conditions, it introduces the FRP to ASW and SUW systems and tactics where the aircraft is "flown" by the instructor at the controlling station. The FRP can practice operating keysets, menu and sub-menu navigation, and checklist utilization. WTT 1 is an introduction the basic functions of the mission display in the aircraft and is conducted during the pilot phase.

WTT 2–10 are oriented to SUW mission systems and tactics in the SUW phase, and WTT 11–16 are focused on ASW mission systems and tactics in the ASW phase

5. Operational Flight Trainer

The OFT is a robust simulation tool used to introduce the FRP to the cockpit layout of switches and circuit breakers, flight and mission displays, and flight controls. It includes the ability to display a simulation of the environment external to the aircraft. This can be amended to display whatever conditions are necessary to complete the required training including day and night, weather phenomena, land and water, other aircraft, and surface vessels. The events conducted in the OFT are OFT 1-10 (basic flight maneuvers and checklists), OFT 11 (introduction to instrument flight), OFT 12 (introduction to SAR procedures), INST X (CNAF-mandated instrument check if conducted in simulator vice aircraft), OTAC 1 (introduction to RADAR, ESM, and MTS prior to TAC 1), OTAC 2 (introduction to formation flight prior to TAC 2), OTAC 4 (introduction to precision guided munitions prior to TAC 4), and OTAC 5 (introduction to SACT and AHM prior to TAC 5), ONATOPS (OFT checkride), and OFT 13 (summary emergency procedure event conducted as the final event in the CAT I syllabus).

6. Tactical Operational Flight Trainer

The TOFT is a combination of the WTT and OFT, where the two modules are linked to improve training for ASW and SUW events in the simulator. Fleet replacement aircrewmen (FRACs) also undergoing syllabus instruction at the FRS integrate during FRP events by running mission systems in the WTT while interacting and coordinating with FRPs in the OFT, simulating a crew completing a mission in the aircraft. The events condcucted in the TOFT configuration include TOFT 1 (introduction to sonar dipping operations prior to DIP 1), TOFT 2X (pre-check event to be completed prior to the ONATOPS), TOFT 3-10X (SUW events), and TOFT 11-18X (ASW events).

C. COLLECTION OF OBSERVED DATA

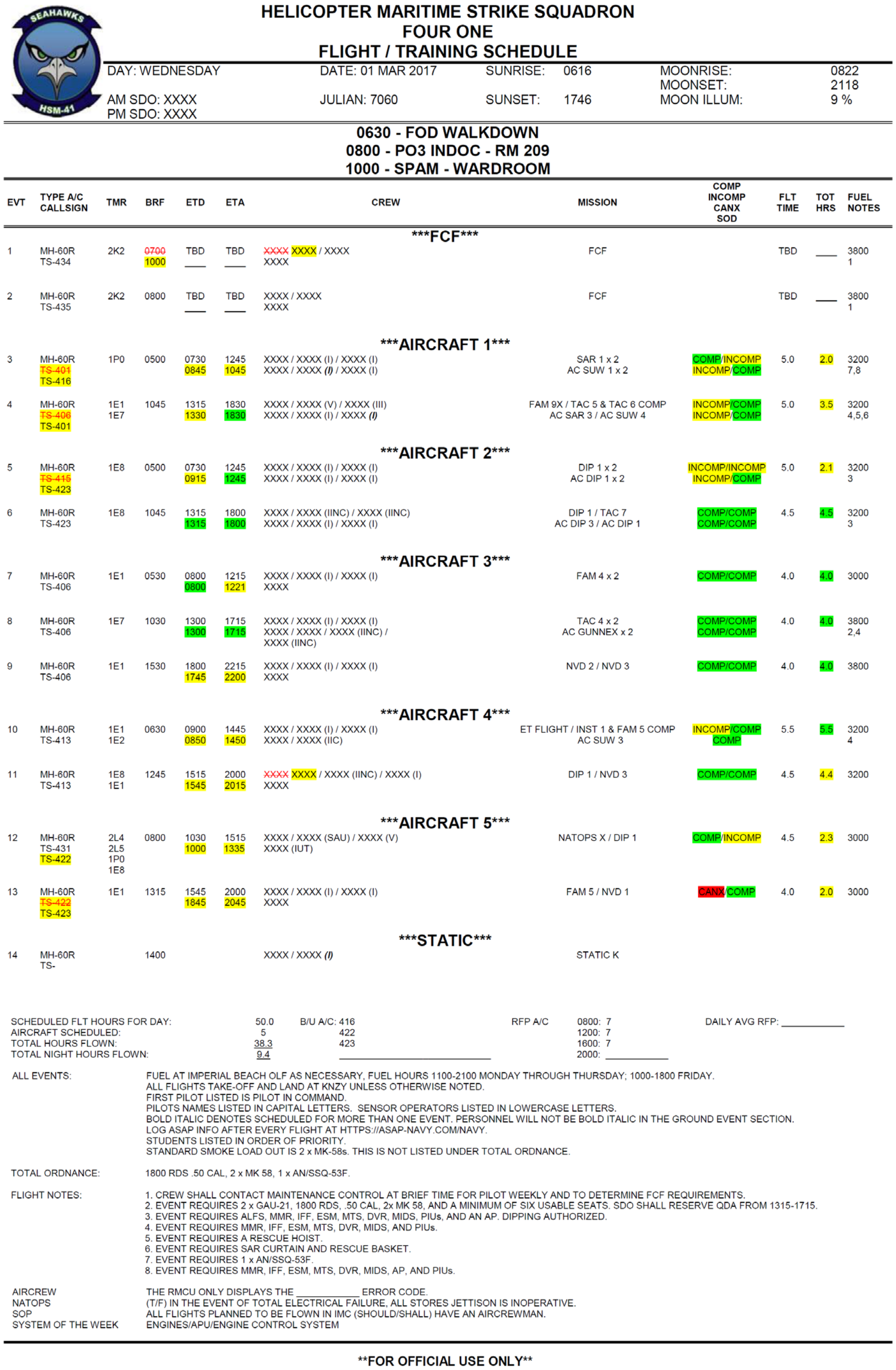
The bank of data required to analyze the proposed research questions adequately did not exist prior to this author's efforts. This fact is relevant as it means that cancellation data other than maintenance and weather are not being tracked by, and presented to, the necessary decision-makers at CNAF. FRS pipeline length is being determined on an incomplete set of data and has the potential to implement and overly optimistic acquisition schedule for fleet replacement pilots. The necessary information is all tracked via annotations on the daily flight schedule, but it is never aggregated in a data bank to allow for thorough and holistic analysis. Therefore, the author manually compiled all of 12 months of data into Microsoft Excel.

Event completion rates and reasons for cancellation were extracted from a full year of completed flight schedules at HSM-41, 7,229 events in all (3,005 flight events and 4,224 simulator events). Each daily flight schedule was reviewed for event completion status. If an event was marked as complete (to include incomplete events that could be scheduled and completed alongside the next syllabus event), it was annotated as such in the data bank. If it was marked as cancelled or required a full re-fly of the event, it was annotated along with the reason for cancellation. Calendar year (CY) 2017 was used as the source of data, as it was the only full year (January to December) where the CAT I FY16v2 syllabus was the only version of the syllabus in use for Category I FRPs. Before 2017, a combination of the FY16 and FY16v2 syllabi were in use at the MH-60R FRS. The FY18 syllabus began rollout in 2018. No major syllabus changes requiring amendments to TTT were instituted in 2017, therefore a major revision was not necessary. Although the differences between the FY16, FY16v2, and FY18 syllabi were minimal, with the addition of a few days to the TTT, the timeframe used for analysis ensured that no additional factors such as different would affect the pool of gathered data with dissimilar syllabi completion timeframes.

Figure 3 and Figure 4 show a completed daily flight schedule. It is common for this to be presented as a two-page schedule with the flight events on the front page (Figure 3) and classroom events/simulator events on the back page (Figure 4). On the front page, the flight events are depicted as numbered events beginning on the left side of the schedule. The event is then read across to the right to determine aircraft side number, total mission requirement (TMR) code, event brief/estimated time of departure (ETD)/estimated time of arrival (ETA) times, names of crew members on the flight, specific training mission, status of completion, scheduled/actual flight time, and specific event notes. In this example, in the status of completion column, multiple events were marked as INCOMP (in yellow), meaning the required training was not completed and either a partial or full re-fly is required. One cancellation is also indicated by a red CANX.

The back page is read in similar form with the classroom events on the top portion of the page and the simulator events below. The simulator used is to the left, syllabus/training event is in the next column, followed by brief/ETA/ETD, assigned instructor, and crew members. There were no issues completing all training in the simulators on this date.

At the bottom of the back page, there are boxes containing some data as to the status of the completed flight schedule's simulator events. The duty officer on this date failed to fill in the information but it is a metric showing how many students were scheduled v. how many students completed the event. Additionally, scheduled simulator hours v. completed simulator hours would be gathered as well. The function of this section is to assist in the determination of contractor scheduling requirements for simulator events.



HELICOPTER MARITIME STRIKE SQUADRON
FOUR ONE
FLIGHT / TRAINING SCHEDULE

DAY: WEDNESDAY | DATE: 01 MAR 2017 | SUNRISE: 0616 | MOONRISE: 0822
AM SDO: XXXX | JULIAN: 7060 | SUNSET: 1746 | MOONSET: 2118
PM SDO: XXXX | MOON ILLUM: 9 %

0630 - FOD WALKDOWN
0800 - PO3 INDOC - RM 209
1000 - SPAM - WARDROOM

EVT	TYPE A/C CALLSIGN	TMR	BRF	ETD	ETA	CREW	MISSION	COMP INCOMP CANX SOD	FLT TIME	TOT HRS	FUEL NOTES
						FCF					
1	MH-60R TS-434	2K2	~~0700~~ 1000	TBD ___	TBD ___	~~XXXX~~ XXXX / XXXX XXXX	FCF		TBD	___	3800 1
2	MH-60R TS-435	2K2	0800	TBD ___	TBD ___	XXXX / XXXX XXXX	FCF		TBD	___	3800 1
						AIRCRAFT 1					
3	MH-60R ~~TS-401~~ TS-416	1P0	0500	0730 0845	1245 1045	XXXX / XXXX (I) / XXXX (I) XXXX / XXXX ***(I)*** / XXXX (I)	SAR 1 x 2 AC SUW 1 x 2	COMP/INCOMP INCOMP/COMP	5.0	2.0	3200 7,8
4	MH-60R ~~TS-406~~ TS-401	1E1 1E7	1045	1315 1330	1830 1830	XXXX / XXXX (V) / XXXX (III) XXXX / XXXX (I) / XXXX ***(I)***	FAM 9X / TAC 5 & TAC 6 COMP AC SAR 3 / AC SUW 4	INCOMP/COMP INCOMP/COMP	5.0	3.5	3200 4,5,6
						AIRCRAFT 2					
5	MH-60R ~~TS-415~~ TS-423	1E8	0500	0730 0915	1245 1245	XXXX / XXXX (I) / XXXX (I) XXXX / XXXX (I) / XXXX (I)	DIP 1 x 2 AC DIP 1 x 2	INCOMP/INCOMP INCOMP/COMP	5.0	2.1	3200 3
6	MH-60R TS-423	1E8	1045	1315 1315	1800 1800	XXXX / XXXX (IINC) / XXXX (IINC) XXXX / XXXX (I) / XXXX (I)	DIP 1 / TAC 7 AC DIP 3 / AC DIP 1	COMP/COMP COMP/COMP	4.5	4.5	3200 3
						AIRCRAFT 3					
7	MH-60R TS-406	1E1	0530	0800 0800	1215 1221	XXXX / XXXX (I) / XXXX (I) XXXX	FAM 4 x 2	COMP/COMP	4.0	4.0	3000
8	MH-60R TS-406	1E7	1030	1300 1300	1715 1715	XXXX / XXXX (I) / XXXX (I) XXXX / XXXX / XXXX (IINC) / XXXX (IINC)	TAC 4 x 2 AC GUNNEX x 2	COMP/COMP COMP/COMP	4.0	4.0	3800 2,4
9	MH-60R TS-406	1E1	1530	1800 1745	2215 2200	XXXX / XXXX (I) / XXXX (I) XXXX	NVD 2 / NVD 3	COMP/COMP	4.0	4.0	3800
						AIRCRAFT 4					
10	MH-60R TS-413	1E1 1E2	0630	0900 0850	1445 1450	XXXX / XXXX (I) / XXXX (I) XXXX / XXXX (IIC)	ET FLIGHT / INST 1 & FAM 5 COMP AC SUW 3	INCOMP/COMP COMP	5.5	5.5	3200 4
11	MH-60R TS-413	1E8 1E1	1245	1515 1545	2000 2015	~~XXXX~~ XXXX / XXXX (IINC) / XXXX (I) XXXX	DIP 1 / NVD 3	COMP/COMP	4.5	4.4	3200
						AIRCRAFT 5					
12	MH-60R TS-431 TS-422	2L4 2L5 1P0 1E8	0800	1030 1000	1515 1335	XXXX / XXXX (SAU) / XXXX (V) XXXX (IUT)	NATOPS X / DIP 1	COMP/INCOMP	4.5	2.3	3000
13	MH-60R ~~TS-422~~ TS-423	1E1	1315	1545 1845	2000 2045	XXXX / XXXX (I) / XXXX (I) XXXX	FAM 5 / NVD 1	CANX/COMP	4.0	2.0	3000
						STATIC					
14	MH-60R TS-		1400			XXXX / XXXX ***(I)***	STATIC K				

SCHEDULED FLT HOURS FOR DAY:	50.0	B/U A/C: 416	RFP A/C	0800: 7	DAILY AVG RFP: ________
AIRCRAFT SCHEDULED:	5	422		1200: 7	
TOTAL HOURS FLOWN:	38.3	423		1600: 7	
TOTAL NIGHT HOURS FLOWN:	9.4	____________		2000: ________	

ALL EVENTS:
FUEL AT IMPERIAL BEACH OLF AS NECESSARY, FUEL HOURS 1100-2100 MONDAY THROUGH THURSDAY; 1000-1800 FRIDAY.
ALL FLIGHTS TAKE-OFF AND LAND AT KNZY UNLESS OTHERWISE NOTED.
FIRST PILOT LISTED IS PILOT IN COMMAND.
PILOTS NAMES LISTED IN CAPITAL LETTERS. SENSOR OPERATORS LISTED IN LOWERCASE LETTERS.
BOLD ITALIC DENOTES SCHEDULED FOR MORE THAN ONE EVENT. PERSONNEL WILL NOT BE BOLD ITALIC IN THE GROUND EVENT SECTION.
LOG ASAP INFO AFTER EVERY FLIGHT AT HTTPS://ASAP-NAVY.COM/NAVY.
STUDENTS LISTED IN ORDER OF PRIORITY.
STANDARD SMOKE LOAD OUT IS 2 x MK-58s. THIS IS NOT LISTED UNDER TOTAL ORDNANCE.

TOTAL ORDNANCE: 1800 RDS .50 CAL, 2 x MK 58, 1 x AN/SSQ-53F.

FLIGHT NOTES:
1. CREW SHALL CONTACT MAINTENANCE CONTROL AT BRIEF TIME FOR PILOT WEEKLY AND TO DETERMINE FCF REQUIREMENTS.
2. EVENT REQUIRES 2 x GAU-21, 1800 RDS, .50 CAL, 2x MK 58, AND A MINIMUM OF SIX USABLE SEATS. SDO SHALL RESERVE QDA FROM 1315-1715.
3. EVENT REQUIRES ALFS, MMR, IFF, ESM, MTS, DVR, MIDS, PIUs, AND AN AP. DIPPING AUTHORIZED.
4. EVENT REQUIRES MMR, IFF, ESM, MTS, DVR, MIDS, AND PIUs.
5. EVENT REQUIRES A RESCUE HOIST.
6. EVENT REQUIRES SAR CURTAIN AND RESCUE BASKET.
7. EVENT REQUIRES 1 x AN/SSQ-53F.
8. EVENT REQUIRES MMR, IFF, ESM, MTS, DVR, MIDS, AP, AND PIUs.

AIRCREW: THE RMCU ONLY DISPLAYS THE ________ ERROR CODE.
NATOPS: (T/F) IN THE EVENT OF TOTAL ELECTRICAL FAILURE, ALL STORES JETTISON IS INOPERATIVE.
SOP: ALL FLIGHTS PLANNED TO BE FLOWN IN IMC (SHOULD/SHALL) HAVE AN AIRCREWMAN.
SYSTEM OF THE WEEK: ENGINES/APU/ENGINE CONTROL SYSTEM

FOR OFFICIAL USE ONLY

Figure 3. Example Completed Flight Schedule 1 of 2. Adapted from Commander Helicopter Maritime Strike Squadron FOUR ONE (2017).

GROUND EVENTS

PERSONNEL IN GROUND EVENTS WILL NOT BE ***BOLD ITALIC AND MUST CHECK THE REMAINDER OF THE SCHEDULE THOROUGHLY***

FRAC CLASS	EVENT	TIME	LOCATION	INSTRUCTOR
XXXX XXXX XXXX	ICW 4.080-.160	TBD	LEARNING CENTER	
XXXX	ICW 7.070-.130	TBD	LEARNING CENTER	
XXXX	ICW 8.100-.120, PTT 7	TBD	LEARNING CENTER	
XXXX	ICW 9.010-.020	TBD	LEARNING CENTER	
XXXX	ICW 9.070-.080	TBD	LEARNING CENTER	
XXXX XXXX	ICW 22.045	TBD	LEARNING CENTER	
XXXX XXXX	PTT 3-4	TBD	LEARNING CENTER	
XXXX	OPEN BOOK	0830	NATOPS	XXXX
XXXX	CAI 9.050-.060	0900-1100	C-10	XXXX
XXXX XXXX	IMAT 11.140-.190, CAI 11.160-.170	0900-1500	C-2	XXXX
XXXX XXXX	CAI 11.010-.025, IMAT 11.020-.030, PHASE 4 INDOC	0900-1500	C-9	XXXX
XXXX	DTTT 1, 2	1500-1700	LEARNING CENTER	XXXX
FRP CLASS	**EVENT**	**TIME**	**LOCATION**	**INSTRUCTOR**
HATCHER	ICW P1.040, 2.010-.040	TBD	LEARNING CENTER	
XXXX XXXX XXXX	ICW P3.010-.030	TBD	LEARNING CENTER	
XXXX	ICW P5.030-.040	TBD	LEARNING CENTER	
XXXX XXXX XXXX XXXX XXXX XXXX	ICW P6.010-.040	TBD	LEARNING CENTER	
XXXX XXXX	ICW P15.030-.050	TBD	LEARNING CENTER	
XXXX	ICW P15.130-.140	TBD	LEARNING CENTER	
XXXX XXXX	ICW P17.060-.072	TBD	LEARNING CENTER	
XXXX XXXX	ICW P17.140	TBD	LEARNING CENTER	
XXXX	ICW P20.050-.060	TBD	LEARNING CENTER	
XXXX	ICW P21.040-0.45, P21.132	TBD	LEARNING CENTER	
XXXX	ICW P24.170, PTT 19-20	TBD	LEARNING CENTER	
XXXX	ICW P24.365-25.010	TBD	LEARNING CENTER	
XXXX	ICW P25.080	TBD	LEARNING CENTER	
XXXX	CRT P22.140	TBD	LEARNING CENTER	
XXXX	PTT 12-13	TBD	LEARNING CENTER	
XXXX XXXX	IGR P17.071	0700-0800	C-3	XXXX
XXXX	CAI P1.030	0800-0900	C-3	XXXX
XXXX	CAI P3.110-.155, JMPS 1-10	0930-1100	C-5	XXXX
XXXX XXXX	IGR P15.150	1200-1300	C-5	XXXX
XXXX	CAI P19.040, P19.120, DTTT	1200-1300	C-3	XXXX
XXXX	CAI P21.060	1230-1330	C-4	XXXX
XXXX	CAI P25.060	1300-1400	C-3	XXXX
XXXX	CAI P15.110	1300-1400	C-5	XXXX
XXXX	IGR P20.090	1400-1500	C-5	XXXX
XXXX	IGR P24.115	1400-1500	C-3	XXXX
XXXX XXXX XXXX	IGR P2.190	1500-1600	C-3	XXXX
MISC	**EVENT**	**TIME**	**LOCATION**	**INSTRUCTOR**
XXXX	MISSION PLANNING WATCH	0400-0800	RM 211	
ALL REQUIRED PERSONNEL	ORDNANCE TRAINING	0600-0700	HANGAR	XXXX
XXXX	MISSION PLANNING WATCH	0800-1200	RM 211	
XXXX XXXX	HITS DAY 2	0800-1200	BLDG 352 RM 201	
XXXX	MISSION PLANNING WATCH	1200-1600	RM 211	
ALL REQUIRED PERSONNEL	CHSMWP AIRCREW TRAINING	1300-1400	C-1	XXXX
ALL REQUIRED PERSONNEL	ORDNANCE TRAINING	1330-1430	HANGAR	XXXX
XXXX XXXX XXXX XXXX XXXX XXXX	TOFT 10X MISSION BRIEF	1700-1800	CONF ROOM	XXXX
XXXX	DIP DUTY OFFICER	1600-2300	IB TOWER	

SIMULATOR EVENTS

TOFT 1, 2, 3 (AOP 15 - BURN CARDS ON GETAC COMPUTERS IN C-3), TOFT 5 (86 SERIES)
SIM OPERATORS PRESENT IN TOFT 1 AND 2 (0600-2200)

TRAINER	EVT	EVENT	BRF	ETD	ETA	INSTRUCTOR	CREW
TOFT 2	1	WTT 13	0500	0600	0800	XXXX	XXXX
	2	OFT TAC 1 x 2	0700	0800	1200	XXXX	XXXX XXXX
	3	WTT 3 x 2	0700	0800	1200	XXXX	XXXX XXXX
	4	TOFT 12 (W/ CST) / TOFT 13	1030	1200	1600	XXXX	XXXX XXXX
	5	CST 7 (W/ TOFT)	1030	1200	1400	XXXX	XXXX
	6	TOFT 13 / TOFT 15	1430	1600	2000	XXXX	XXXX XXXX
	7	OFT 11 x 2	1900	2000	2359	XXXX	XXXX XXXX
TOFT 3	8	OFT TAC 5 x 2	0700	0800	1200	XXXX	XXXX XXXX
	9	WTT 14 / WTT 15	0700	0800	1200	XXXX	XXXX XXXX
	10	TOFT 11 / WTT 15	1100	1200	1600	XXXX	XXXX XXXX
	11	OFT NATOPS X / WTT 5 (IN OFT)	1200	1400	1800	XXXX	XXXX XXXX
	12	WTT 5 / WTT 6	1500	1600	2000	XXXX	XXXX XXXX
	13	OFT 12 / OFT 5	1700	1800	2200	XXXX	XXXX XXXX
TOFT 5	14	WTT 11 / WTT 12	0500	0600	1000	XXXX	XXXX XXXX
	15	OFT TAC 1 x 2	0900	1000	1400	XXXX	XXXX XXXX
	16	AC PRE-NATOPS WTT x 2	0900	1000	1400	XXXX	XXXX XXXX
	17	OFT DLQ 1 x 2	1300	1400	1800	XXXX	XXXX XXXX
	18	WTT 6 / WTT 8	1300	1400	1800	XXXX	XXXX XXXX
	19	TOFT 10X (W/ TACEVAL) / WTT 11	1700	1800	2200	XXXX	XXXX XXXX
	20	ACTC SUW TACEVAL (W/ TOFT)	1700	1800	2000	XXXX	XXXX

Simulators					
FRP	**SKED**	**COMP**	**FRAC**	**SKED**	**COMP**
CAT I	25		CAT I	3	
CAT IIC	0		CAT IIC	2	
CAT IINC	4		CAT IINC	0	
CAT III	1		CAT III	0	
CAT V	0				

	ALLOCATED	FLOWN	REMAINING
Q4	2388.0	1220.6	1167.4

SIM HOURS	SCHEDULED	COMP
CIS	48.0	
AW CIS	66.0	

NOTES

Flights: 1/11: Swapped XXXX for XXXX due to XXXX not an FCP. Swapped XXXX for XXXX for NVD 3. XXXX took XXXX classes.
3: Late launch/swap to backup due to preflight gripes (FOD in engine compartment, blown sonolauncher gauge)
4: Swapped to 401 due to bent FLIR (required for TAC 5/TAC 6). XXXX incomplete due to EGI malfunction in flight, recommend additional 2.0 to complete.
5: Late launch/swap to backup due to suspected TGB overserviced. Early recovery due to ICS gripe. XXXX incomplete recommend full refly, XXXX incomplete recommend extra 1.0 on next event to complete review items, Anderson incomplete.
6: Dome wet for all personnel
7: Late recovery due to popped corner fastener between students.
10: ET flight executed but additional ET flight recommended.
12: Swapped from 431 to 422 due to broken door handle, transmission oil pressure low. Did not launch in 431 due to hydraulic leak. XXXX incomplete due to aircraft issues, recommend full refly.
13: XXXX cancelled due to troubleshooting hydraulic leak from previous event, recommend full refly. Event rolled to 423 due to hydraulic leak from previous event.

Sims:

SUBMITTED BY:	REVIEWED BY:	APPROVED BY:
XXXX LCDR USN OPERATIONS OFFICER	XXXX LCDR USN MAINTENANCE OFFICER	XXXX CDR USN COMMANDING OFFICER

Figure 4. Example Completed Flight Schedule 2 of 2. Adapted from Commander Helicopter Maritime Strike Squadron FOUR ONE (2017).

After review of the data contained in the flight schedules and from own experience as a FRS instructor pilot, the author determined that not all cancellation factors were summarized as either a maintenance or weather related issue and determined that two additional factors warranted consideration. Other identified cancellation factors were statistically irrelevant (i.e., ship unable to support DLQ events due to a shipboard engineering casualty) or easily corrected (i.e., being scheduled for incorrect syllabus event resulted in a pen-and-ink change on the flight schedule to complete next required event).

The FRPs, FRACs, and their instructors are human beings, and consequently, are subject to experiencing “off days” where the individual may be contending with an illness or home-life stressor where their focus is not on the full and safe completion of the scheduled event. In this circumstance, the individual would “ORM out” of the event for the day, and either a replacement would be substituted or the event is lost.

Another non-zero contributor is when the FRP is not prepared for the event or does not complete the event within required standards of performance. In this case, a SOD is warranted. Although rare, the consequence of receiving a SOD forces the loss of the scheduled event that day, and at a minimum, the FRP is not scheduled for a syllabus event the next day while undergoing phase performance review by the FRPs class advisor, the Standardization Officer, and the Training Officer. When dealing with the number of events conducted and FRP throughput required annually by the FRS, even cancellation percentages of less than 1% can add up.

Table 2 illustrates the results of the data collection efforts. Initial observation of the raw data shows that for CY2017, simulator completion rates are well within acceptable standards, with an observed summary cancellation rate of approximately 2.47% (sum of maintenance, SOD, and ORM cancellations). Conversely, the flight cancellation rate exceeds 20%, much higher than the allotted 15% from the TTT calculation in CNAF 1500.12.

Table 2. Cancellation Data Derived from HSM-41 Flight Schedules

SIMULATOR		
METRIC	VALUE	%
SCHEDULED EVENTS	4244	N/A
COMPLETED EVENTS	4139	97.53%
CANX - MAINTENANCE	79	1.86%
CANX - SOD	8	0.19%
CANX - ORM	18	0.42%

FLIGHT		
METRIC	VALUE	%
SCHEDULED EVENTS	3005	N/A
COMPLETED EVENTS	2375	79.03%
CANX - MAINTENANCE	249	8.29%
CANX - WEATHER	294	9.78%
CANX - SOD	16	0.53%
CANX - ORM	71	2.36%

D. SYLLABUS MODEL SYNTHESIS

As illustrated earlier in Table 1, of the 164 syllabus days there are 85 events conducted in the aircraft or simulator. The other 79 days are relegated solely to a classroom. In the analysis of flight schedules for CY2017, not a single classroom training day was annotated as lost on the schedule. The probabilistic risk of a lost training day due to a lack of classroom or instructor availability in a given timeframe is essentially zero. Therefore, for the purpose of this thesis and the formulation of the model, the author narrowed the scope by including only flight and simulator events. The 85 flight and simulator events are broken down into four phases: Pilot, DLQ, SUW, and ASW.

When scheduling FRPs for events at the FRS, the primary planning tool is the Daily Planner, an addendum to the syllabus submitted to CNAF for approval that is written and designed by the Curriculum Officer and the civilian Education Specialist assigned to HSM-41. This tool specifies the syllabus events (classroom, lab, aircraft, or simulator) that are slated for each day. The intent is to ensure that the training day does not exceed 8.0 hours as required by CNAF 1500.12, while also ensuring event scheduling is optimized to take full advantage of each training day.

The pre-requisite guide (Table 3) is a document that assists the training and operations departments at the FRS in scheduling events that authorized to occur out of the order stipulated in the Daily Planner to minimize disruption in the progression of FRPs in the syllabus. This may occur due to a lack of scheduling ability i.e., FRP has a medical appointment and is unable to come in for an event until later or rapid progression through classroom events that provide opportunities to complete other flight or simulator events. The guide explicitly specifies events that must be completed as a pre-requisite to other events. For example, OFT 11 is a pre-requisite for OFT 12, FAM 6N, and INST 1. Before the modeling conducted in this thesis, the FRS was not using a graphical depiction of the information contained in Table 3.

Using a combination of the FRP Category I FY16v2 Daily Planner, the pre-requisite guide, and first-hand knowledge of scheduling practices at the FRS, a basic FFBD was generated to give a macro view of the CAT I FRP syllabus as illustrated in Figure 5. The ATO Phase, comprised of the SUW Phase and the ASW Phase conducted in order, must occur after the Pilot Phase. The DLQ Phase must occur after the Pilot Phase, but can be conducted simultaneously with the ATO Phase. NVD 2 and NVD 3 are FAM flights that can be completed at any point after completing NVD 1 but are generally scheduled during the ATO Phase due to significantly reduced number of flight events in that phase of training. The final event in the syllabus is OFT 13. All other events must be complete before being scheduled for it.

Table 3. CAT I Pre-requisite Guide. Source: MH-60R Curriculum Model Manager (2016).

MH-60R CAT I PRE-REQUISITE GUIDE (FY16v2)		
PILOT PHASE		
All events should be scheduled in order per the daily planner to the maximum extent practical. This guide is the aboslute minimum prerequisite guide.		
Events shall not be combined with the next event if it is a prerequisite.		
No events shall be combined with any "X" event		
EVENT	**PREREQUISITE**	**NOTES**
FAM 0 (Preflight/Postflight/Egress)	FAM A, B, C	ONWING (OPTIONAL)
FAM 1 (Checklists, Course Rules, and Basic Flight Operations)	OFT 10, **FAM 0**, CAI 7.060	ONWING
WTT 1 (Navigation Systems)	IGR 8.050	
OFT 11 (INST) (Navigation System and Instrument Flight Procedures)	WTT 1	
FAM 6N (Night FAM - Unaided Intro)	OFT 11	
INST 1 (Basic Instrument Flight)	OFT 11	
INST 2N (Night Basic, Radio Instruments, and Airways)	**FAM 6N**	
OFT 12 (SAR)	OFT 11, IGR 9.120	
SAR 1 (Day/Night SAR and Coupled Hover EPs)	OFT 12	2.5 hrs
TOFT 1 (Sonar Dipping Operations and Procedures)	**SAR 1**	
DIP 1 (Day/Night Sonar Dipping Ops and Procedures)	TOFT 1	2.5 Hrs
NVD 1 (Intro to Basic NVD Flight Ops)	**SAR 1**, NITE LAB	
SAR 2N (Night Dipping OPS and Night SAR)	**SAR 1, DIP 1, NVD 1**	
Instrument Check	**INST 2N**, HITS, MIN. APPR.	WITHIN 60 DAYS OF HITS
FAM 8 (FAM Stage Review)	**FAM 7, SAR 2N**	
TOFT 2X (SAR/Dipping, EP Review, Phase Review)	**FAM 7, SAR 2N**	
FAM 9X (FAM, SAR, Dipping Phase X)	**FAM 8**	2.5 Hrs
OFT NATOPS X	NATOPS Chalk Talk, **FAM 9X. TOFT 2X**	
NATOPS X	OFT NATOPS X	OPEN/CLOSED BOOK COMPLETE 2.5 Hrs
FAM 10 (UTIL) (Cargo and Logistics Flight)	NATOPS X, ICW P13.020-.040	1.0 Hrs
OFT DLQ 1 (Day DLQ/RLQ)	CAI P15.110, **NATOPS X**	
FDLPs	OFT DLQ 2	1.0 Hrs per student
DLQ 1 (Day DLQ) / DLQ 2 (Night DLQ)	**FDLPs**	
ATO PHASE		
All TOFTs and WTTs shall be completed in order.		
All OFT TAC events shall be completed prior to the corresponding TAC event.		
EVENT	**PREREQUISITE**	**NOTES**
WTT 8 (MTS Operations)	DTTT 1	
OFT TAC 1	WTT 8	
TAC 1 (MMR/IFF/ESM Operations)	OFT TAC 1	ISAR G/S if able
TAC 2 (TACFORM)	OFT TAC 2, CAI P19.120	
TAC 3 (CAL/LZ)	ICW P19.110	
TOFT 3 (Surveillance Operations)	IGR 20.090	
TOFT 4 (Hellfire EX)	WTT 9	
OFT TAC 4 (MTS/Hellfire EX)	WTT 10	
TOFT 5 (Remote Designation)	OFT TAC 4	
OFT TAC 5 (AHC, EM, SACT Intro)	IGR P21.320	
TOFT 6 (HELLFIRE/OTH-T)	OFT TAC 5, IGR P21.320	
TAC 4 (FHS FAM Flight)	OFT TAC 4, TOFT 5	
TAC 5 (AHC, SACT)	OFT TAC 5, IGR P21.320	
TAC 6 (SUW Overview)	TOFT 6	
TOFT 10X (SUW TAC Evaluation)	TOFT 9, P22.085 SUW Phase Test	
WTT 11 (Sonar Patterns & Tracking)	IGR 24.115, ICW 24.175	
TOFT-14 (Line of Bearing Search)	IGR P24.410, TOFT 13	
TAC 7 (USW: Sonar Dome, Dip-to-Dip Nav, Buoys)	IGR 24.410, TOFT 13	
TOFT 15 (USW Screen Tactics)	TOFT 14, CAI 25.060	
TAC 8 (ATO/FAM Review)	TOFT 17	
TOFT 18X (USW TAC Evaluation)	TOFT 17, P25.135 USW Phase Test	
OFT 13 (EP Review Sim)	TOFT 18X	

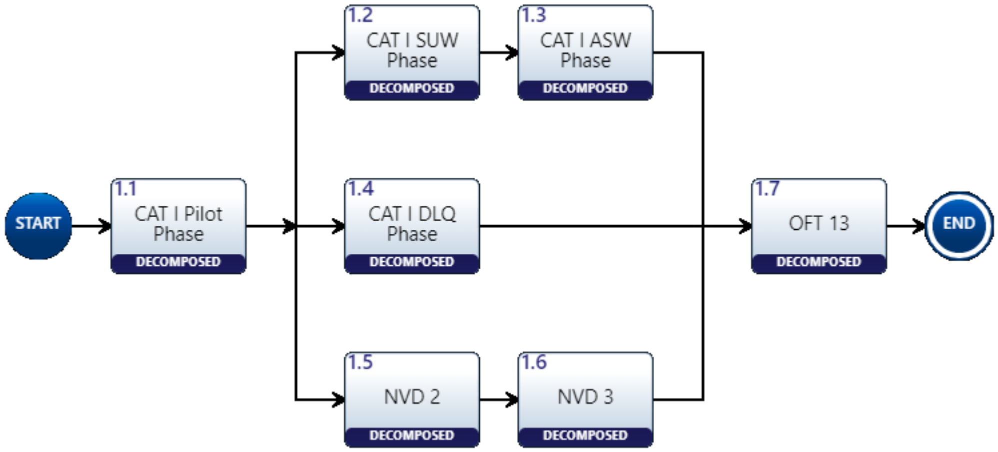


Figure 5. CAT I FRP Syllabus FFBD

The FFBD in Figure 5 is further decomposed into detailed FFBDs for the respective phases of training. The Pilot Phase, containing 34 flight and simulator events is depicted in Figure 6 and is encompassed by training days 01 to 71 as depicted in the Daily Planner in Appendix A. The SUW Phase is depicted in Figure 7 and is encompassed by training days 80 to 130. The ASW Phase, encompassing training days 131 to 163, is depicted in Figure 8, and the DLQ Phase, comprised of only five events, is conducted in order: ODLQ 1, ODLQ 2, FDLPN, DLQ 1, and DLQ 2. The DLQ events encompass training days 72 to 79, but as stated earlier are flown any time after the completion of the Pilot Phase and before being scheduled for OFT 13. These training day timeframes include numerous dedicated classroom events and hybrid classroom/simulator or flight training days. If the student is wholly cancelled for a flight or sim, they are rescheduled for the lost classroom day as well.

To simplify model depiction, some similar events were grouped together for the phase model (i.e., OFT 1–OFT 10 depicted in Figure 6 is decomposed into each individual event in the next level down).

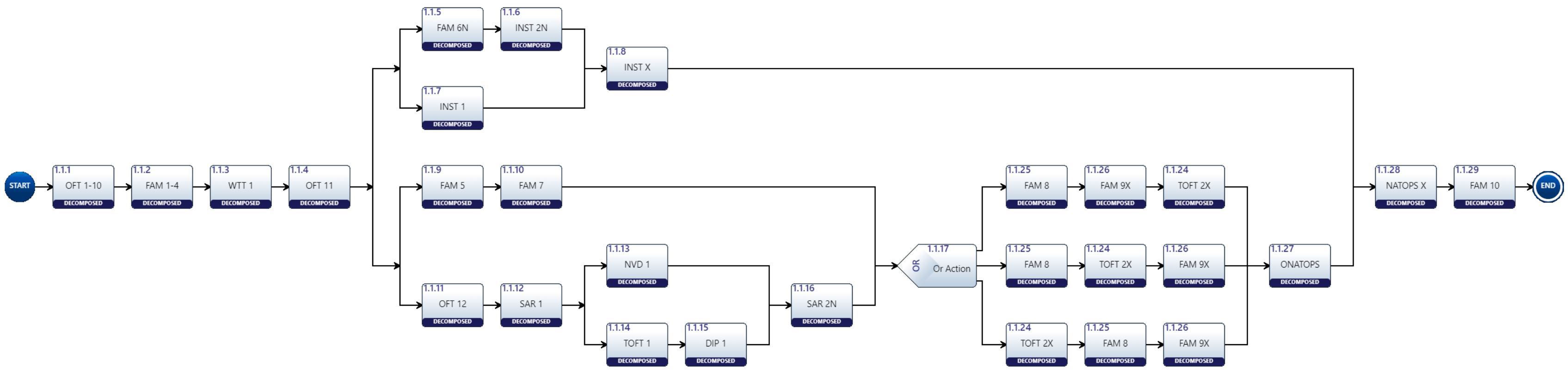


Figure 6. Pilot Phase FFBD

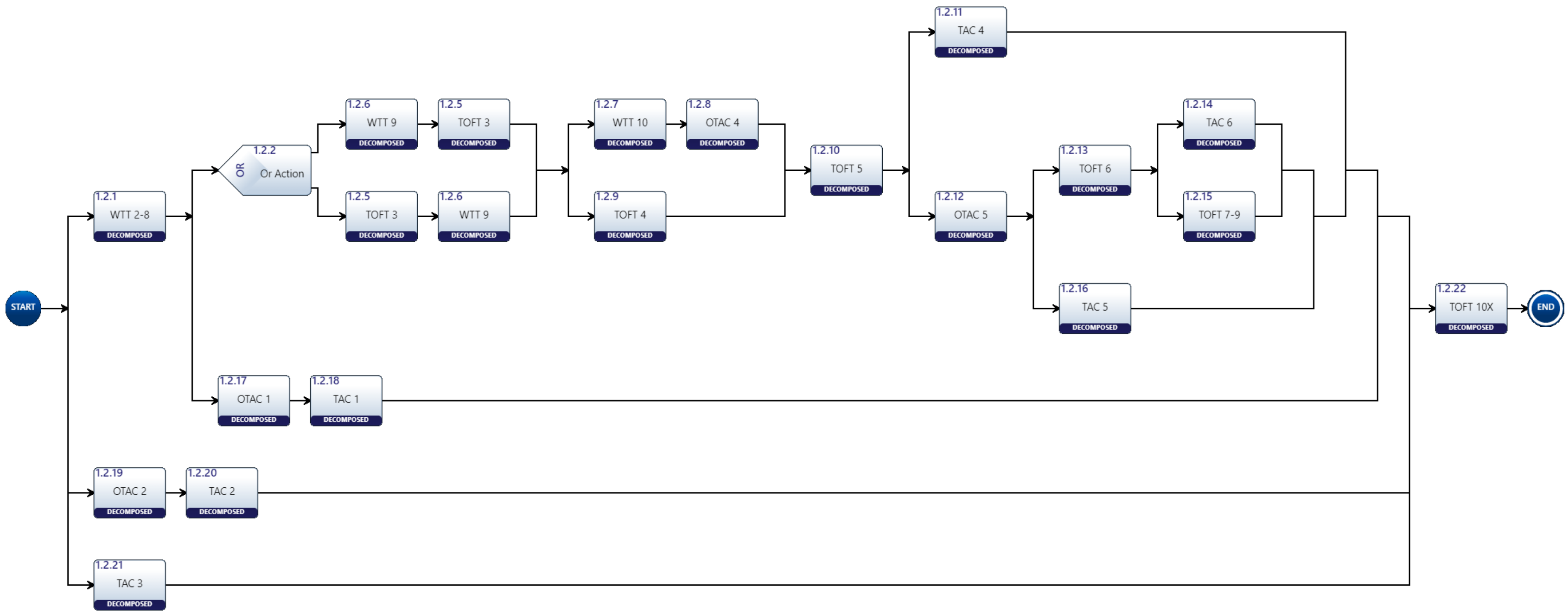


Figure 7. SUW Phase FFBD

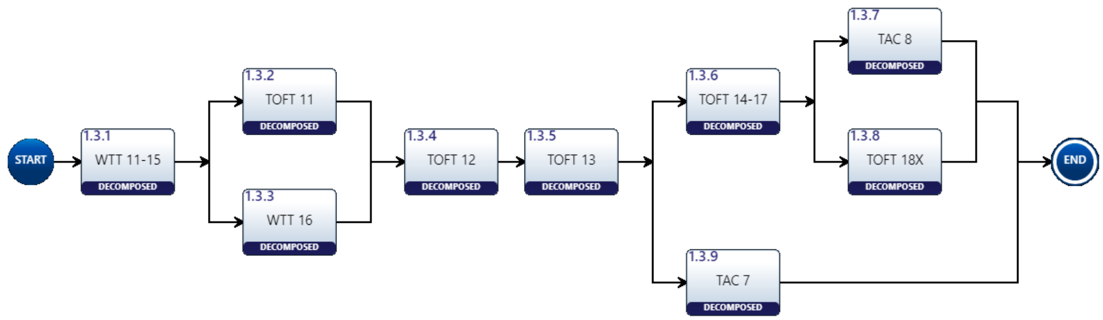


Figure 8. ASW Phase FFBD

Each depicted event was further decomposed to add probabilistic loop logic gates for each cancellation metric: maintenance (MX), weather (WX) (aircraft only), ORM, SOD. To prevent the loop gates from artificially increasing the length of time required to execute the syllabus, a completion time of 1 second was applied to the logic gates.

The rates determined from the flight schedule analysis and depicted in Table 2, were used to Continue/Exit the loop logic gate. An event probability greater than the cancellation rate metric would exit the loop, while a probability less than the cancellation metric would remain in the loop and cause a loss of one to two days per iteration. Figure 9 illustrates this for FAM 1 and is a representative model for all the flight events. Figure 10 is a representative indication of a simulator event.

The INST X, depicted in Figure 11, is a unique event for the syllabus. As it can be accomplished in either the aircraft or the simulator, an additional logic module (OR gate) was added to allow for probabilistic selection of the appropriate mode of execution based on the number of events completed in the simulator versus the aircraft in CY 2017 [48 in the simulator (63.16%), 28 in the aircraft (36.84%)].

Each fully decomposed event is scheduled to take 24 hours in the simulation, as well as the SIT A DAY placeholder in the loop logic gate.

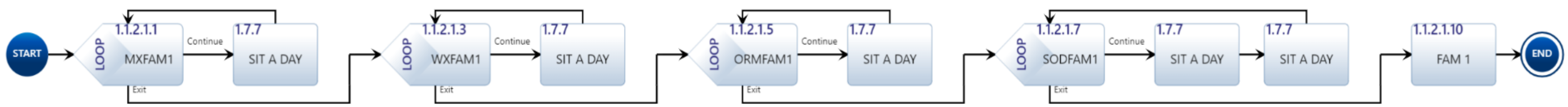


Figure 9. FAM 1 (Decomposed FFBD)

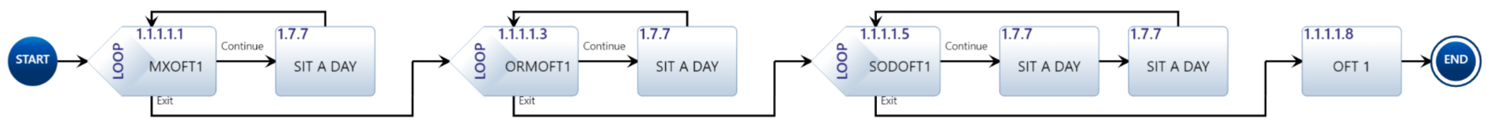


Figure 10. OFT 1 (Decomposed FFBD

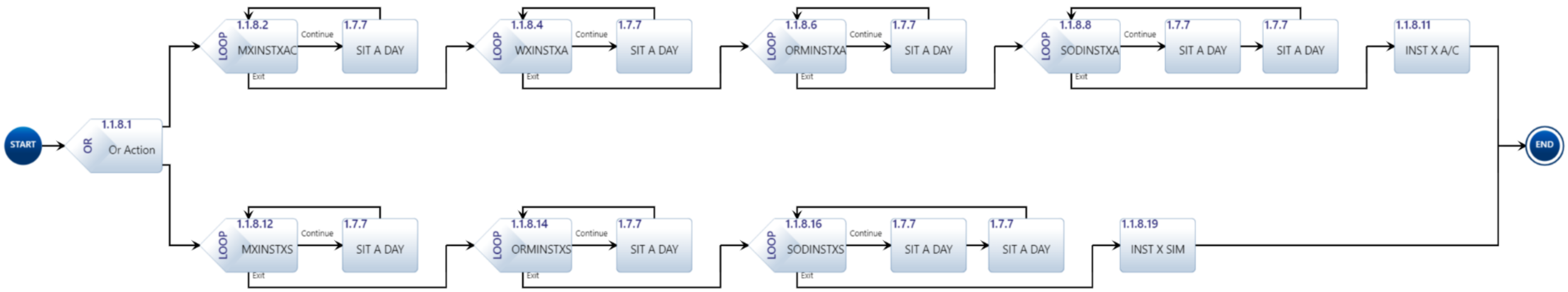


Figure 11. INST X (Decomposed FFBD)

E. MODEL SIMULATION

Due to the aforementioned limitations of the available software regardsing post-simulation data extraction, discrete simulations of the syllabus model were conducted. In order to improve the validity of the testing results, 100 discrete simulations were conducted and a thorough review of the Gantt chart produced by the Innoslate software was completed for each simulation. Figure 12 illustrates a portion of the Gantt chart from a discrete simulation of the syllabus model. In this depiction, three loop logic gates were activated, simulated lost days/cancelled events. Two days are lost on TAC 2 for maintenance, and one day is lost on TAC 3 for ORM. Also visible is the fact that TAC 1 and TAC 3 began on the same day in the model and TAC 3 continued due to cancellation and flew simultaneously while TAC 2 lost its first day for maintenance.

The sum of all days lost due to any cancellation factor were totaled for each simulation by counting depictions of loop logic gate activations in the Gantt Chart. Additionally, the reason for cancellations were tallied alongside the event type (i.e., WX cancellation for a DLQ flight). The results are presented in the next chapter.

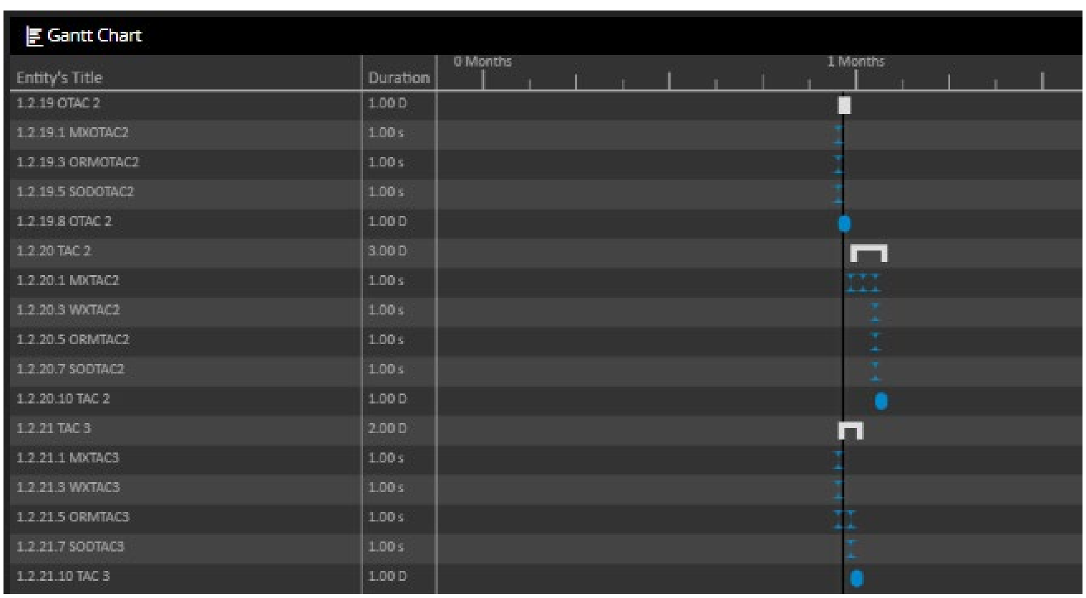


Figure 12. Representative Gantt Chart Example. Source: Innoslate (2021).

F. SUMMARY

This chapter presented the methods that were applied to develop a FFBD for the Category I FRP syllabus. Data gathered from the daily flight schedule was compiled and then implemented in the model in the form of logic gates that would determine whether the event completed successfully or forced the simulated FRP to sit for a day, completing no training and delaying completion of the syllabus. Due to aforementioned software limitations, discrete simulations were conducted rather than Monte Carlo simulations. The next chapter contains a review of the cancellation metrics that are currently in use for planning and the data gathered from the discrete simulations conducted for this thesis.

IV. PRESENTATION OF DATA

A. PROPOSED SCHEDULE CANCELLATION RATES

Every student that arrives at HSM-41 is being trained to, upon graduation, fill a billet in a deployable squadron for a minimum of three years. Timing of arrival is critical in minimizing manpower shortages for deployments and daily squadron operations as senior individuals in the squadron begin to transition out to their next tours. Maintaining manpower requirements is essential to retaining necessary squadron readiness. Every event cancellation increases the risk that the FRP does not complete the syllabus in the required timeline and delays arrival to his fleet squadron.

Each airframe model manager is responsible for the development, implementation and annual systematic review of training syllabi for his airframe. HSM-41 is the model manager for the MH-60R, making the Curriculum Officer at the FRS the Course Curriculum Model Manager, and the individual responsible for organizing and managing the effort of syllabus updates and maintenance. Part of that process is determining the TTT of newly proposed and revised syllabi, including adding days as necessary via multiplier to flight and simulator events due to cancellations caused by maintenance and weather. The multiplier on the current syllabus adds 8 days to the TTT, meaning that syllabus allots only 8 days for events lost specifically to weather and maintenance (aircraft and simulator).

As illustrated in Table 1, the TTT for syllabus completion includes the addition of eight days to factor in cancellations due to aircraft maintenance (three days), weather delays (two days), and contracted simulator availability (three days). Although an addition an additional 18 days are added in the Training Days to Pipeline Days conversion, these days are added to account for previously discussed military command-centric requirements and are not added as a function of time required to train.

Therefore, of the 85 training days most susceptible to training delays, an allotment of eight additional days is included to ensure an on-time completion of all syllabus requirements. No simulation was required to determine these results as this is not the current method utilized by CNAF and OPNAV to determine additional days to allocate due to cancellations.

B. RESULTS OF ACTUAL SCHEDULE CANCELLATION RATES

The drivers for cancellation that are currently accounted for are maintenance and weather. Although anecdotally these two factors are often the most prevalent issues affecting scheduled operations, they have been shown to be inadequate in capturing all event cancellations. They only account for two external influences and fail to recognize the possibility of internal factors, such as the need to opt out of an event due to Operational Risk Management (ORM) with concerns such as illness, crew rest, or emotional trauma (i.e., death in family or illness) or the student fails to meet the required standards of the event and is conferred a signal of difficulty (SOD), where syllabus progression and performance is reviewed prior to continuing.

Using the data gathered from flight schedule analysis and illustrated in Table 2, and the models previously shown, 100 discrete simulations of the CAT I syllabus model were run. The results of the simulations are illustrated in Table 4 and Table 5. In total, across 100 simulations, 820 total days were lost (average of 8.2 days per simulation).

Cells highlighted in green on Table 4 indicate that the syllabus completed in the allotted amount of time (85 event days + 8 cancellation days = 93 days) with a minimum of 84 days and a maximum of 93 days. Cells highlighted in red indicate the syllabus took more than the allotted number of days. Of the 100 discrete simulations, 42 simulations indicate the syllabus took longer than required (Minimum = 94 days, Maximum = 102). Table 5 shows the distribution of lost days to syllabus events. The cancellation factors associated with the highest numbers of lost days for flight events were maintenance and weather, while the cancellation factor with the highest number of lost days for simulator events was for maintenance.

Table 4. Total Flight/Sim Syllabus Length Simulation Data (1 of 2)

Iteration	# of Days	Excess	Iteration	# of Days	Excess
1	94	9	51	94	9
2	93	8	52	96	11
3	93	8	53	90	5
4	90	5	54	95	10
5	91	6	55	92	7
6	93	8	56	95	10
7	92	7	57	92	7
8	94	9	58	99	14
9	93	8	59	96	11
10	90	5	60	90	5
11	97	12	61	92	7
12	96	11	62	90	5
13	95	10	63	92	7
14	93	8	64	99	14
15	92	7	65	95	10
16	90	5	66	95	10
17	95	10	67	94	9
18	94	9	68	97	12
19	91	6	69	93	8
20	94	9	70	91	6
21	97	12	71	92	7
22	89	4	72	92	7
23	90	5	73	97	12
24	92	7	74	90	5
25	92	7	75	92	7
26	91	6	76	90	5
27	101	16	77	97	12
28	94	9	78	96	11
29	95	10	79	91	6
30	92	7	80	91	6
31	92	7	81	94	9
32	95	10	82	92	7
33	92	7	83	90	5
34	96	11	84	89	4
35	102	17	85	97	12
36	89	4	86	98	13
37	95	10	87	90	5
38	87	2	88	91	6
39	91	6	89	95	10
40	90	5	90	89	4
41	92	7	91	97	12
42	93	8	92	96	11
43	93	8	93	93	8
44	93	8	94	97	12
45	89	4	95	94	9
46	94	9	96	96	11
47	93	8	97	93	8
48	92	7	98	98	13
49	89	4	99	93	8
50	89	4	100	94	9

Table 5. Total Flight/Sim Syllabus Length Simulation Data (2 of 2)

	Lost Days (per 100 simulations)			
Event Type	Maintenance	Weather	ORM	SOD
WTT Simulator	29		4	8
OFT Simulator	23		8	8
OTAC Simulator	7		2	0
TOFT Simulator	33		9	2
FAM Flight	173	209	49	16
TAC Flight	69	79	25	10
DLQ Flight	23	17	3	14

The data from Table 4 was analyzed using the Data Analysis tool in Microsoft Excel, the results showing the frequency of occurrence for each excess day total. Table 6 shows the data in raw form with an additional column dedicated to showing the frequency of number of days lost as a cumulative percentage. Of note, the table illustrates that more than 50% of all simulations required an additional eight days (the limit authorized by the CNAF-approved TTT) or more. At the same time, the contracted simulator cancellation rate of 5% is significantly higher than the observed loss of simulator events due to maintenance issues in the discrete simulations.

$$29 + 23 + 7 + 33 = 92 \text{ lost days}$$

$$92 / (55 \text{ simulator events per syllabus} * 100 \text{ discrete simulations}) = 1.67\%$$

This data, charted in Figure 13, shows a right-skewed, near normal distribution of excess training days (minimum–2, maximum–17, median–8, mean–8.2). Frequency of occurrence is annotated on the left axis (bar graph) and cumulative percentage is annotated on the right axis (line graph). Further analysis of this data is presented in the next chapter.

Table 6. Number of Days Lost versus Frequency of Occurrence

# Of Excess Days	*Frequency*	*Cumulative %*
2	1	1.01%
3	0	1.01%
4	7	8.08%
5	12	20.20%
6	8	28.28%
7	17	45.45%
8	13	58.59%
9	10	68.69%
10	10	78.79%
11	7	85.86%
12	8	93.94%
13	2	95.96%
14	2	97.98%
15	0	97.98%
16	1	98.99%
17	1	100.00%

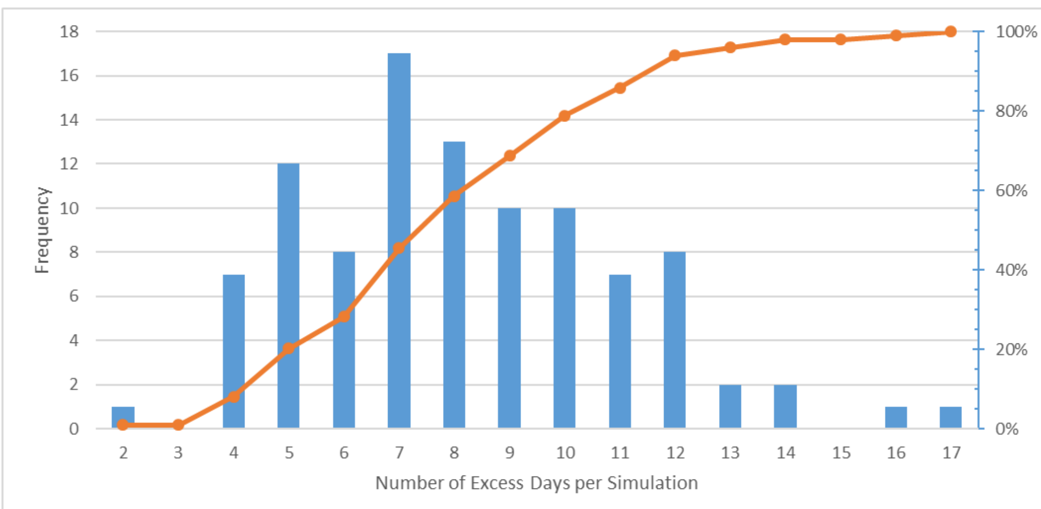


Figure 13. Number of Days Lost versus Frequency of Occurrence

C. SUMMARY

The data collected during the discrete simulations conducted in Innoslate is indicative of an incomplete planning practices currently in place to determine syllabus length. By not considering all statistically relevant cancellation factors, decisions being made with incomplete data are at risk of yielding imprecise results. Combining a probabilistic approach and a comprehensive list of cancellation factors in the design and development of a syllabus model illustrates that, when using real-world data, the target delivery date for Category I FRPs is missed, or at risk, more than 50% of the time. The following chapter provides an overall conclusion to this thesis, focusing on answering the questions presented in Chapter I. Also presented are recommendations for the employment of the information gathered and for future work and anecdotal observations made while completing this thesis.

V. CONCLUSIONS AND RECOMMENDATIONS

A. REVIEW OF RESEARCH QUESTIONS

The purpose of this thesis was to provide answers to the following questions:

- Can a systems engineering analysis identify shortcomings of the current syllabus as a schedule for the fleet replacement squadron system?
- Are all causes for cancellation accounted for in the syllabus planning process?
- Are the requisite completion timeframes for Category I FRP graduation rates to fleet squadrons consistently within acceptable tolerances?
- Are proposed cancellation rates indicative of observed cancellation rates?

It is evident that the systems engineering analysis of the syllabus as a schedule has identified shortcomings in the planning process for the acquisition of a trained FRP asset. The stakeholders and participants of the system, CNAF/OPNAV and fleet squadrons, benefit greatly from the modeling of the syllabus as a FFBD, transferring a text-based schedule with a detached pre-requisite guide to an easily digested model in a visual format. By modeling the syllabus in Innoslate, the opportunity was afforded to apply garnered cancellation metrics in a probabilistic format to yield meaningful data to support future syllabus planning and revision.

Combining the experience gained by the author while as an instructor pilot at HSM-41 with the raw data gathered from the review of 12 months of actual daily flight schedule data, it is evident that not all cancellation factors are incorporated by CNAFINST 1500.12 in the evaluation of syllabus duration. By only accounting for maintenance and weather cancellation factors for flight events, although the most prolific of the observed and measured cancellation factors, significant contributors to lost days are not accounted for. For example, 1.58 days are lost on average per syllabus simulation due to operational risk management considerations and student signal of difficulty events. When rounded up in accordance with CNAFINST 1500.12 guidance, the factor equates to two additional days that were not previously accounted for as a metric for delay. This is regardless of the application of other cancellation metrics that are currently being accounted for.

Combining the latter two research questions, the answer is a matter of interpretation of the data. The syllabus model in Innoslate revealed an average cancellation loss rate of 8.2 days per discrete simulation. This is remarkably close to the accepted cancellation loss rate of eight days per the time-to-train calculation (within 2.47%). Without further consideration, it could be misunderstood that the current cancellation factors are sufficient and no further effort is necessary to determine system improvement.

What this metric fails to illustrate is that this factor of 8.2 days would still round up to nine days (11.76% difference) as there is no accounting for partial days in the syllabus. Additionally, at this data point, there are an equal number of simulations below this value as there are above it. Meaning, in 50% of all iterations, the syllabus fails to operate within the predetermined scope. The decision-makers, in this case CNAF, would need to determine his acceptable level of risk for an other-than-on-time completion of the FRS syllabus.

According to the data contained in Figure 13, a success rate of 80% equates to a cancellation factor of approximately 11 days. 80% of all students undergoing instruction in the CAT I syllabus will complete the syllabus with 11 days or less lost due to aircraft maintenance cancellations, weather cancellations, simulator maintenance cancellations, ORM considerations, or SOD events. In other words, if only three additional days are granted to account for unscheduled cancellations, the probability of on-time completion is at least 80% for each FRP.

B. ANECDOTAL OBSERVATIONS

While writing this thesis, I determined other factors that are worthy of note, but not necessarily influential in the analysis of this particular model. Further research into these areas have the potential to yield additional data that could further improve the scheduling process at the FRS, as well as other similar repetitive DOD acquisition systems.

(1) How is the FRS Meeting the Mission?

With the data presented in this thesis, why is there not a documented problem with FRPs completing the syllabus within the requisite timeline? The primary safeguard is prioritized scheduling. All FRPs have a projected completion date. The pace of syllabus execution is measured against a glideslope between syllabus initiation and intended completion date. If a student begins to fall below glideslope, their scheduling becomes the priority, to include prioritization of their specific events on the flight schedule above other FRP events and double-scheduling of classroom days and/or simulator events. The other measure is the 10% flexibility factor accounting for holidays, squadron safety standdowns, command inspections, changes of command, and similar events when computing Training days (T-days) to Pipeline days (P-days). At the point in the calculation when the P-days are being summed, the cancellation factors have already been applied, and the syllabus stands at 172 T-days, meaning an additional 17.2 days (18.0 after rounding) are added to account for these miscellaneous factors. Changes of command generally occur, at most, twice in a calendar year at the FRS, safety standdowns are a quarterly requirement (four per year), and holiday leave periods generally only cover five business days (along with the preceding and following weekends). There is still a surplus of seven working days, and these days share the load with the other unplanned cancellations when holiday leave periods. These latent factors do not eliminate the necessity of proper planning and determination of potential schedule excess when implementing syllabus revisions and conducting required annual syllabus reviews.

(2) Maintenance and “First Go’s”

From the author’s experience and observations as an FRS instructor pilot, when weather cancellations are not considered, flight event cancellations due to maintenance are more often associated with “first-go’s” than other flight events. “First-go’s” are the events that initiate the flight schedule, the first events of the day where the crews walk to preflight the aircraft and start it up before continuing with the event. During preflight, the crews check the aircraft and all its compartments and components for overall corrosion, foreign object debris (FOD), condition, security, and servicing (Naval Air Systems Command

2020). Subsequent crews will hot-seat into the aircraft, turning over the aircraft without shutting down and starting back up. During this pre-flight, the crew might discover discrepancies that may have been overlooked by the maintenance team. The discrepancies have varying times to correct, and many times the first events on the flight schedule will subsequently be annotated as Incomplete or Cancelled due to insufficient minimum time required versus allocated or insufficient time to complete all the required items on the gradesheet.

(3) "May Gray" and "June Gloom"

Weather during certain times of the year has the potential to become problematic in Southern California. Phenomena known as "May Gray" or "June Gloom" materializes due to the interaction of warm, high-pressure air over the cold waters of the Pacific Ocean. This causes a temperature inversion and the formation of low cloud levels and a foggy marine layer (Tragesar 2012). This phenomenon often breaks up by the early afternoon as the sun breaks up cloud layer and disperses the marine layer, but it can often remain for the entire day. Due to NAS North Island's proximity to the coast, when the layer develops, most flight events on the schedule are cancelled and rescheduled for a later date. There is nothing that can be done to mitigate this issue other than to relocate the FRS to another airfield unaffected by it.

(4) Problematic Syllabus Events

Of note, there are a few events that precede check-ride events, culminating events at the end of a phase, and events with greater technical knowledge required for discussion items prior to the event that have proven troublesome. Specifically, these events are FAM 9X/TOFT 2X, TOFT 9 and TOFT 17. FAM 9X and TOFT 2X are the precursor events before the NATOPS and ONATOPS evaluations respectively. If there is any doubt that a student may not be successful on their NATOPS or ONATOPS, the FRP is given a SOD and subsequent event re-fly or extra training (ET) event. This prevents a failure of the NATOPS check process from becoming a permanent entry in the pilot's NATOPS training jacket. TOFT 9 and TOFT 17 are precursor events to the respective SUW and ASW checkrides. By minimizing the chance for failure on a TOFT 10X or TOFT 18X, there is reduced likelihood that the FRP will need to go through a Training Review Board, formal review process facilitated by the Standardization Officer, Training Department Head, and Executive or Commanding Officer that can take multiple days, delaying syllabus completion even more than a SOD on TOFT 9 or 17. Therefore, these events are more likely to result in a SOD compared to other events at a similar timeframe in the syllabus, and there is a lower likelihood that a failure is observed on a NATOPS X, ONATOPS, TOFT 10X, or TOFT 18X.

C. RECOMMENDATIONS

The syllabus at the FRS undergoes constant review and modification. At a minimum, the syllabus is required to be annually reviewed in entirety. If there are only minor changes (meaning no requirement to add events necessitating the increase of TTT), then the Model Manager need only coordinate with other fleet replacement squadrons of the same type/model/series and concur on changes. Major revisions, including those that add days to the TTT, require submission and approval in accordance with CNAFINST 1500.12.

The primary issue is that the existing TTT calculation is an incomplete process. It incorporates the framework of a plan to coordinate for event cancellation but employs insufficient metrics for realistic planning purposes. It is currently a function of planning for the best and hoping for better. As indicated by the results of the 100 discrete simulations of the model presented in this thesis, the cancellation factor excess has a mean of 8.2 days (9.0 days when rounding). By applying the data from the simulations and incorporating it into a probabilistic risk assessment, stakeholders can gain additional confidence in completion rates by adding 11 days to the master course schedule instead of the current eight days. This difference of three days equates to an approximate 80% probability of an on-time completion of the syllabus (versus less than 50% at eight days). It is the recommendation of this author to employ a method, such as the one demonstrated in this thesis, to more accurately plan for schedule deviations at the MH-60R FRS.

D. AREAS FOR FURTHER RESEARCH

There is direct correlation between the FRS syllabus at HSM-41 and other FRS training syllabi and flight training syllabi across the Naval Aviation Enterprise (NAE). All fleet replacement squadrons utilize computer aided training, classroom events, simulator events, and flight events to train the pilots, flight officers, and aircrew that will employ the aircraft in the fleet. Every other platform that the U.S. Navy employs in the fleet (MH-60S Knighthawk, MH-53E Sea Dragon, F/A-18 Hornet, E/A-18 Growler, E-2C/D Hawkeye, C-2A Greyhound, F-35 Lightning II, P-8A Poseidon, and E-6B Mercury) operates a fleet replacement squadron to train newly winged naval aviators to operate and employ their respective aircraft. These syllabi incorporate simulator and flight training events that could be modeled and measured in much the same way as presented in this thesis. The same could be applied to earlier phases of flight training such as Primary, Intermediate, and Advanced.

Combining an all-inclusive list of cancellation factors with a probabilistic modeling approach has the potential to yield accurate syllabus length figures for training units throughout the Department of Defense.

This thesis focused on flight and simulator syllabus events, as they are more susceptible to cancellation than computer-aided training and classroom events. An improvement upon the model would be to incorporate the entire syllabus into it, including self-guided computer lessons and instructor-led classes.

E. IN CLOSING

The scope of the cancellation numbers discussed in this thesis are objectively on the low end. When compared to the length of the syllabus at the MH-60R FRS and the thousands of events completed at HSM-41 each year, the addition of three days to a syllabus spanning approximately nine months appears inconsequential. But the systematic approach presented in this thesis is illustrative of a more thorough and data-driven process than what is currently in place. By utilizing model-based simulations combined with a probabilistic risk assessment, the approach to determining syllabus length is more deliberate and data-driven. It is, therefore, more quantifiable and repeatable in other similarly designed schedule-driven acquisition systems.

APPENDIX: CAT I SYLLABUS DAILY PLANNER

The following tables are from the FY 2016 v2 Category I FRP syllabus as generated by Commander Helicopter Maritime Strike Squadron FOUR ONE (2016).

Table 1. Category I FRP Syllabus Daily Planner (1 of 9).

WEEK ONE														
DAY 1			DAY 2			DAY 3			DAY 4			DAY 5		
TYPE	EVENT	HRS	TYPE	EVENT	HRS	TYPE	EVENT	HRS	TYPE	EVENT	HRS	TYPE	EVENT	HRS
CAI	P1.010	1.5	CAI	P1.050	4.0	IGR	P1.080	1.5	ICW	P2.040	2.0	PTT 1	P2.080	2.0
CAI	P1.020	1.5	CAI	P1.060	2.0	ICW	P2.010	2.0	ICW	P2.050	2.0	PTT 2	P2.090	2.0
CAI	P1.030	1.5	CAI	P1.070	2.0	ICW	P2.020	2.0	CAI	P2.070	1.5	ICW	P2.110	2.0
ICW	P1.040	1.5				ICW	P2.030	2.0	ICW	P2.100	1.0	ICW	P2.120	1.0
TRAINING HOURS		6.0	TRAINING HOURS		8.0	TRAINING HOURS		7.5	TRAINING HOURS		6.5	TRAINING HOURS		7.0
WEEK TWO														
DAY 6			DAY 7			DAY 8			DAY 9			DAY 10		
TYPE	EVENT	HRS	TYPE	EVENT	HRS	TYPE	EVENT	HRS	TYPE	EVENT	HRS	TYPE	EVENT	HRS
ICW	P2.150	1.5	IGR	P2.190	2.0	ICW	P3.040	2.0	ICW	P3.080	2.0	CAI	P3.110	1.0
CAI	P2.160	1.5	ICW	P3.010	2.0	ICW	P3.050	2.0	ICW	P3.090	2.0	CAI	P3.150	1.0
PTT 3	P2.170	2.0	ICW	P3.020	2.0	ICW	P3.060	2.0	ICW	P3.100	2.0	CAI	P3.155	1.0
PTT 4	P2.180	2.0	ICW	P3.030	2.0	ICW	P3.070	2.0				JMPS 1-10	P3.120-P3.220	5.0
TRAINING HOURS		7.0	TRAINING HOURS		8.0	TRAINING HOURS		8.0	TRAINING HOURS		6.0	TRAINING HOURS		8.0
WEEK THREE														
DAY 11			DAY 12			DAY 13			DAY 14			DAY 15		
TYPE	EVENT	HRS	TYPE	EVENT	HRS	TYPE	EVENT	HRS	TYPE	EVENT	HRS	TYPE	EVENT	HRS
OFT 1	P3.230	6.0	ICW	P3.250	2.0	CAI	P3.300/10	1.5	IGR	P3.320	2.0	OFT 2	P3.330	6.0
CAI	P3.240	1.5	ICW	P3.260	2.0	ICW	P4.010	2.0	EXAM	P3.340	2.0	IGR	P4.050	2.0
			ICW	P3.270	2.0	ICW	P4.020	2.0	ICW	P4.040	1.5			
			ICW	P3.280	2.0	ICW	P4.030	1.5						
TRAINING HOURS		7.5	TRAINING HOURS		8.0	TRAINING HOURS		7.0	TRAINING HOURS		5.5	TRAINING HOURS		8.0
WEEK FOUR														
DAY 16			DAY 17			DAY 18			DAY 19			DAY 20		
TYPE	EVENT	HRS	TYPE	EVENT	HRS	TYPE	EVENT	HRS	TYPE	EVENT	HRS	TYPE	EVENT	HRS
OFT 3	P4.070	6.0	ICW	P4.090	2.0	IGR	P4.130	2.0	OFT 4	P4.140	6.0	NITE LAB	P4.210	5.0
ICW	P4.080	2.0	ICW	P4.100	2.0	FAM A	P4.135	2.0				CAI	P4.220	1.0
			ICW	P4.110	2.0	ICW	P4.200	1.0				ICW	P4.230	1.0
			ICW	P4.120	2.0									
TRAINING HOURS		8.0	TRAINING HOURS		8.0	TRAINING HOURS		5.0	TRAINING HOURS		6.0	TRAINING HOURS		7.0

Table 2. Category I FRP Syllabus Daily Planner (2 of 9)

WEEK FIVE														
DAY 21			DAY 22			DAY 23			DAY 24			DAY 25		
TYPE	EVENT	HRS	TYPE	EVENT	HRS	TYPE	EVENT	HRS	TYPE	EVENT	HRS	TYPE	EVENT	HRS
OFT 5	P4.150	6.0	ICW	P5.010	2.0	OFT 6	P5.050	6.0	ICW	P5.060	1.5	IGR	P5.110	2.0
			ICW	P5.020	2.0				ICW	P5.070	1.5	FAM B	P5.120	2.0
			ICW	P5.030	2.0				ICW	P5.080	1.5			
			ICW	P5.040	2.0				ICW	P5.090	1.5			
									ICW	P5.100	1.5			
TRAINING HOURS		6.0	TRAINING HOURS		8.0	TRAINING HOURS		6.0	TRAINING HOURS		7.5	TRAINING HOURS		4.0
WEEK SIX														
DAY 26			DAY 27			DAY 28			DAY 29			DAY 30		
TYPE	EVENT	HRS	TYPE	EVENT	HRS	TYPE	EVENT	HRS	TYPE	EVENT	HRS	TYPE	EVENT	HRS
OFT 7	P5.130	6.0	ICW	P6.010	2.0	IGR	P6.050	2.0	OFT 8	P6.060	6.0	IGR	P6.100	2.0
			ICW	P6.020	2.0	ICW	P6.070	2.0				FAM C	P6.110	2.0
			ICW	P6.030	2.0	ICW	P6.080	2.0						
			ICW	P6.040	2.0	ICW	P6.090	2.0						
TRAINING HOURS		6.0	TRAINING HOURS		8.0	TRAINING HOURS		8.0	TRAINING HOURS		6.0	TRAINING HOURS		4.0
WEEK SEVEN														
DAY 31			DAY 32			DAY 33			DAY 34			DAY 35		
TYPE	EVENT	HRS	TYPE	EVENT	HRS	TYPE	EVENT	HRS	TYPE	EVENT	HRS	TYPE	EVENT	HRS
OFT 9	P6.120	6.0	ICW	P7.010	2.0	ICW	P7.040	2.0	PTT 5	P7.067	2.0	IGR	P7.065	2.0
			ICW	P7.020	2.0	ICW	P7.050	2.0	WTT 1	P8.060	6.0	FAM 0	P7.080	3.0
			ICW	P7.025	2.0	CAI	P7.060	1.5						
			CAI	P7.030	1.5	ICW	P7.066	2.0						
TRAINING HOURS		6.0	TRAINING HOURS		7.5	TRAINING HOURS		7.5	TRAINING HOURS		8.0	TRAINING HOURS		5.0
WEEK EIGHT														
DAY 36			DAY 37			DAY 38			DAY 39			DAY 40		
TYPE	EVENT	HRS	TYPE	EVENT	HRS	TYPE	EVENT	HRS	TYPE	EVENT	HRS	TYPE	EVENT	HRS
OFT 10	P7.070	6.0	FAM 1	P7.090	5.0	FAM 2	P7.100	5.0	FAM 3	P7.110	5.0	FAM 4	P7.120	5.0
TRAINING HOURS		6.0	TRAINING HOURS		5.0	TRAINING HOURS		5.0	TRAINING HOURS		5.0	TRAINING HOURS		5.0

Table 3. Category I FRP Syllabus Daily Planner (3 of 9)

WEEK NINE														
DAY 41			**DAY 42**			**DAY 43**			**DAY 44**			**DAY 45**		
TYPE	**EVENT**	**HRS**	**TYPE**	**EVENT**	**HRS**	**TYPE**	**EVENT**	**HRS**	**TYPE**	**EVENT**	**HRS**	**TYPE**	**EVENT**	**HRS**
FAM 5	P7.130	5.0	ICW	P8.010	2.0	HITS Day 1	P8.000	8.0	HITS Day 2	P8.000	4.0	OFT 11	P8.070	6.0
			ICW	P8.020	2.0									
			IGR	P8.050	2.0									
TRAINING HOURS		5.0	TRAINING HOURS		6.0	TRAINING HOURS		8.0	TRAINING HOURS		4.0	TRAINING HOURS		6.0
WEEK TEN														
DAY 46			**DAY 47**			**DAY 48**			**DAY 49**			**DAY 50**		
TYPE	**EVENT**	**HRS**	**TYPE**	**EVENT**	**HRS**	**TYPE**	**EVENT**	**HRS**	**TYPE**	**EVENT**	**HRS**	**TYPE**	**EVENT**	**HRS**
FAM 6N	P8.080	5.0	INST 1	P8.090	5.0	INST 2N	P8.100	5.0	INST X	P8.110	6.0	ICW	P9.010	2.0
												ICW	P9.020	2.0
												ICW	P9.030	2.0
												ICW	P9.040	1.0
TRAINING HOURS		5.0	TRAINING HOURS		5.0	TRAINING HOURS		5.0	TRAINING HOURS		6.0	TRAINING HOURS		7.0
WEEK ELEVEN														
DAY 51			**DAY 52**			**DAY 53**			**DAY 54**			**DAY 55**		
TYPE	**EVENT**	**HRS**	**TYPE**	**EVENT**	**HRS**	**TYPE**	**EVENT**	**HRS**	**TYPE**	**EVENT**	**HRS**	**TYPE**	**EVENT**	**HRS**
ICW	P9.050	1.0	ICW	P9.080	2.0	IGR	P9.120	2.0	OFT 12	P9.130	6.0	SAR 1	P9.140	5.5
ICW	P9.060	2.0	ICW	P9.090	2.0									
ICW	P9.070	2.0	CAI	P9.100	1.5									
ICW	P9.075	2.0	PTT 6	P9.110	2.0									
TRAINING HOURS		7.0	TRAINING HOURS		7.5	TRAINING HOURS		2.0	TRAINING HOURS		6.0	TRAINING HOURS		5.5
WEEK TWELVE														
DAY 56			**DAY 57**			**DAY 58**			**DAY 59**			**DAY 60**		
TYPE	**EVENT**	**HRS**	**TYPE**	**EVENT**	**HRS**	**TYPE**	**EVENT**	**HRS**	**TYPE**	**EVENT**	**HRS**	**TYPE**	**EVENT**	**HRS**
ICW	P10.010	2.0	ICW	P10.040	2.0	TOFT 1	P10.070	6.0	DIP 1	P10.080	5.0	NVD 1	P10.090	5.0
CAI	P10.020	1.5	ICW	P10.060	2.0									
PTT 7	P10.030	2.0	IGR	P10.065	2.0									
TRAINING HOURS		5.5	TRAINING HOURS		6.0	TRAINING HOURS		6.0	TRAINING HOURS		5.0	TRAINING HOURS		5.0

Table 4. Category I FRP Syllabus Daily Planner (4 of 9)

WEEK THIRTEEN														
DAY 61			DAY 62			DAY 63			DAY 64			DAY 65		
TYPE	EVENT	HRS	TYPE	EVENT	HRS	TYPE	EVENT	HRS	TYPE	EVENT	HRS	TYPE	EVENT	HRS
SAR 2N	P10.100	5.0	CAI	P11.010	1.5	FAM 7	P11.030	5.0	FAM 8	P11.050	5.0	TOFT 2X	P12.040	6.0
			EXAM	P12.020	4.0									
			EXAM	P12.030	2.0									
TRAINING HOURS		5.0	TRAINING HOURS		7.5	TRAINING HOURS		5.0	TRAINING HOURS		5.0	TRAINING HOURS		6.0
WEEK FOURTEEN														
DAY 66			DAY 67			DAY 68			DAY 69			DAY 70		
TYPE	EVENT	HRS	TYPE	EVENT	HRS	TYPE	EVENT	HRS	TYPE	EVENT	HRS	TYPE	EVENT	HRS
FAM 9X	P12.050	5.0	OFT NATOPS X	P12.060	6.0	NATOPS X	P12.070	5.5	ICW	P13.020	2.0	CRT	P12.080	0.5
									ICW	P13.030	2.0	CAI	P15.010	1.5
									ICW	P13.040	2.0	ICW	P15.020	2.0
TRAINING HOURS		5.0	TRAINING HOURS		6.0	TRAINING HOURS		5.5	TRAINING HOURS		6.0	TRAINING HOURS		4.0
WEEK FIFTEEN														
DAY 71			DAY 72			DAY 73			DAY 74			DAY 75		
TYPE	EVENT	HRS	TYPE	EVENT	HRS	TYPE	EVENT	HRS	TYPE	EVENT	HRS	TYPE	EVENT	HRS
FAM 10	P13.060	5.0	ICW	P15.030	2.0	ICW	P15.060	3.0	CAI	P15.110	1.5	OFT DLQ 1	P15.120	6.0
			ICW	P15.040	2.0	ICW	P15.070	3.0	ICW	P15.130	2.0	IGR	P15.150	2.0
			ICW	P15.050	2.0				ICW	P15.140	2.0			
TRAINING HOURS		5.0	TRAINING HOURS		6.0	TRAINING HOURS		6.0	TRAINING HOURS		5.5	TRAINING HOURS		8.0
WEEK SIXTEEN														
DAY 76			DAY 77			DAY 78			DAY 79			DAY 80		
TYPE	EVENT	HRS	TYPE	EVENT	HRS	TYPE	EVENT	HRS	TYPE	EVENT	HRS	TYPE	EVENT	HRS
OFT DLQ 2	P15.160	6.0	FDLPs	P15.170	5.0	DLQ 1	P15.180	5.0	DLQ 2	P15.190	5.0	ATO INDOC	P16.001-.0(	3.5
									CRT	P15.200	0.5	INTEL	P16.010-.060	4.0
												ICW	P16.045	1.0
TRAINING HOURS		6.0	TRAINING HOURS		5.0	TRAINING HOURS		5.0	TRAINING HOURS		5.5	TRAINING HOURS		8.5

Table 5. Category I FRP Syllabus Daily Planner (5 of 9)

WEEK SEVENTEEN														
DAY 81			DAY 82			DAY 83			DAY 84			DAY 85		
TYPE	EVENT	HRS	TYPE	EVENT	HRS	TYPE	EVENT	HRS	TYPE	EVENT	HRS	TYPE	EVENT	HRS
CAI	P17.010	1.5	ICW	P17.060	2.0	ICW	P17.076	2.0	ISAR -1	P17.000	5.5	ISAR -2	P17.000	5.5
ICW	P17.030	2.0	ICW	P17.070	1.0	ICW	P17.078	2.0				CAI	P17.075	1
CAI	P17.040	1.5	ICW	P17.072	2.0	PTT 8	P17.086	2.0						
ICW	P17.050	2.0	IGR	P17.071	2.0	PTT 9	P17.090	2.0						
TRAINING HOURS		7.0	TRAINING HOURS		7.0	TRAINING HOURS		8.0	TRAINING HOURS		5.5	TRAINING HOURS		6.5
WEEK EIGHTEEN														
DAY 86			DAY 87			DAY 88			DAY 89			DAY 90		
TYPE	EVENT	HRS	TYPE	EVENT	HRS	TYPE	EVENT	HRS	TYPE	EVENT	HRS	TYPE	EVENT	HRS
WTT 2	P17.100	6.0	WTT 3	P17.120	6.0	PTT 10	P17.142	2.0	WTT 4	P17.150	6.0	WTT 5	P17.160	6.0
			ICW	P17.140	2.0	PTT 11	P17.148	2.0						
						CAI	P17.144	1.5						
						IGR	P17.145	2.0						
TRAINING HOURS		6.0	TRAINING HOURS		8.0	TRAINING HOURS		7.5	TRAINING HOURS		6.0	TRAINING HOURS		6.0
WEEK NINETEEN														
DAY 91			DAY 92			DAY 93			DAY 94			DAY 95		
TYPE	EVENT	HRS	TYPE	EVENT	HRS	TYPE	EVENT	HRS	TYPE	EVENT	HRS	TYPE	EVENT	HRS
ICW	P18.010	2.0	CAI	P18.040	1.5	WTT 6	P18.090	6.0	ICW	P18.100	2.0	CAI	P18.150	1.0
ICW	P18.020	2.0	CAI	P18.045	1.5				ICW	P18.110	2.0	PTT 14	P18.140	2.0
JMPS 11	P18.030	1.0	PTT 12	P18.060	2.0				ICW	P18.120	2.0	IGR	P18.155	2.0
			PTT 13	P18.070	2.0				ICW	P18.130	2.0			
TRAINING HOURS		5.0	TRAINING HOURS		7.0	TRAINING HOURS		6.0	TRAINING HOURS		8.0	TRAINING HOURS		5.0
WEEK TWENTY														
DAY 96			DAY 97			DAY 98			DAY 99			DAY 100		
TYPE	EVENT	HRS	TYPE	EVENT	HRS	TYPE	EVENT	HRS	TYPE	EVENT	HRS	TYPE	EVENT	HRS
WTT 7	P18.160	6.0	ICW	P19.010	2.0	CAI	P19.040	1.5	WTT 8	P19.060	6.0	OFT TAC 1	P19.070	6.0
			ICW	P19.020	2.0	DTTT	P19.050	2.0						
			ICW	P19.030	2.0	CAI	P19.120	1.5						
TRAINING HOURS		6.0	TRAINING HOURS		6.0	TRAINING HOURS		5.0	TRAINING HOURS		6.0	TRAINING HOURS		6.0

Table 6. Category I FRP Syllabus Daily Planner (6 of 9)

WEEK TWENTY-ONE														
DAY 101			DAY 102			DAY 103			DAY 104			DAY 105		
TYPE	EVENT	HRS	TYPE	EVENT	HRS	TYPE	EVENT	HRS	TYPE	EVENT	HRS	TYPE	EVENT	HRS
TAC 1	P19.100	5.0	OFT TAC 2	P19.130	6.0	TAC 2	P19.140	5.0	NVD 2	P19.150	5.0	NVD 3	P19.160	5.0
ICW	P19.110	2.0												
TRAINING HOURS		7.0	TRAINING HOURS		6.0	TRAINING HOURS		5.0	TRAINING HOURS		5.0	TRAINING HOURS		5.0
WEEK TWENTY-TWO														
DAY 106			DAY 107			DAY 108			DAY 109			DAY 110		
TYPE	EVENT	HRS	TYPE	EVENT	HRS	TYPE	EVENT	HRS	TYPE	EVENT	HRS	TYPE	EVENT	HRS
TAC 3	P19.170	5.0	CAI	P20.010	1.5	ICW	P20.050	2.0	TOFT 3	P20.100	6.0	ICW	P21.040	2.0
			ICW	P20.030	2.0	ICW	P20.060	2.0				ICW	P21.045	2.0
			ICW	P20.040	2.0	CAI	P20.090	1.5				CAI	P21.060	1.5
			CAI	P20.045	1.5							ICW	P21.132	2.0
TRAINING HOURS		5.0	TRAINING HOURS		7.0	TRAINING HOURS		5.5	TRAINING HOURS		6.0	TRAINING HOURS		7.5
WEEK TWENTY-THREE														
DAY 111			DAY 112			DAY 113			DAY 114			DAY 115		
TYPE	EVENT	HRS	TYPE	EVENT	HRS	TYPE	EVENT	HRS	TYPE	EVENT	HRS	TYPE	EVENT	HRS
PTT 15	P21.065	2.0	WTT 9	P21.110	6.0	TOFT 4	P21.120	6.0	WTT 10	P21.130	6.0	OFT TAC 4	P21.140	6.0
ICW	P21.070	2.0												
ICW	P21.080	2.0												
CAI	P21.135	1.5												
TRAINING HOURS		7.5	TRAINING HOURS		6.0	TRAINING HOURS		6.0	TRAINING HOURS		6.0	TRAINING HOURS		6.0
WEEK TWENTY-FOUR														
DAY 116			DAY 117			DAY 118			DAY 119			DAY 120		
TYPE	EVENT	HRS	TYPE	EVENT	HRS	TYPE	EVENT	HRS	TYPE	EVENT	HRS	TYPE	EVENT	HRS
TOFT 5	P21.150	6.0	TAC 4	P21.160	5.0	TOFT 6	P21.170	6.0	ICW	P21.180	2.0	ICW	P21.220	1.5
									CAI	P21.190	1.5	CAI	P21.230	1.5
									ICW	P21.200	1.5	CAI	P21.240	1.5
									ICW	P21.210	1.5	CAI	P21.250	1.5
TRAINING HOURS		6.0	TRAINING HOURS		5.0	TRAINING HOURS		6.0	TRAINING HOURS		6.5	TRAINING HOURS		6.0

Table 7. Category I FRP Syllabus Daily Planner (7 of 9)

WEEK TWENTY-FIVE														
DAY 121			DAY 122			DAY 123			DAY 124			DAY 125		
TYPE	EVENT	HRS	TYPE	EVENT	HRS	TYPE	EVENT	HRS	TYPE	EVENT	HRS	TYPE	EVENT	HRS
PTT 16	P21.260	2.0	CAI	P21.300	1.5	OFT TAC 5	P21.330	6.0	TAC 5	P21.340	5.0	TOFT 7	P22.020	6.0
CAI	P21.270	1.5	CAI	P21.310	1.5				ICW	P22.010	2.0			
ICW	P21.280	1.5	IGR	P21.320	2.0									
CAI	P21.290	1.5												
TRAINING HOURS		6.5	TRAINING HOURS		5.0	TRAINING HOURS		6.0	TRAINING HOURS		7.0	TRAINING HOURS		6.0
WEEK TWENTY-SIX														
DAY 126			DAY 127			DAY 128			DAY 129			DAY 130		
			TYPE	EVENT	HRS	TYPE	EVENT	HRS	TYPE	EVENT	HRS	TYPE	EVENT	HRS
TOFT 8	P22.070	6.0	IGR	P22.080	2.0	TOFT 9	P22.090	6.0	TAC 6	P22.130	5.0	TOFT 10X	P22.120	6.0
			EXAM	P22.085	1.0							CRT	P22.140	0.5
TRAINING HOURS		6.0	TRAINING HOURS		3.0	TRAINING HOURS		6.0	TRAINING HOURS		5.0	TRAINING HOURS		6.5
WEEK TWENTY-SEVEN														
DAY 131			DAY 132			DAY 133			DAY 134			DAY 135		
TYPE	EVENT	HRS	TYPE	EVENT	HRS	TYPE	EVENT	HRS	TYPE	EVENT	HRS	TYPE	EVENT	HRS
OCEANO DAY 1			OCEANO DAY 2			OCEANO DAY 3			IGR	P23.180	2.0	ASW G/S	P24.030	1.5
CAI	P23.010	1.0	IMAT	P23.060	1.0	IMAT	P23.120	1.0	CAI	P24.010	1.5	CAI	P24.040	1.5
IMAT	P23.020	1.0	IMAT	P23.070	1.0	IMAT	P23.130	1.0	JMPS 12	P24.020	3.0	CAI	P24.045	1.5
CAI	P23.025	1.0	IMAT	P23.080	1.0	IMAT	P23.140	1.0				PTT 17	P24.050	2.0
IMAT	P23.030	1.0	IMAT	P23.090	1.0	IMAT	P23.170	2.0						
IMAT	P23.040	1.0	IMAT	P23.100	1.0									
IMAT	P23.050	1.0	IMAT	P23.110	1.0									
TRAINING HOURS		6.0	TRAINING HOURS		6.0	TRAINING HOURS		6.0	TRAINING HOURS		6.5	TRAINING HOURS		6.5
WEEK TWENTY-EIGHT														
DAY 136			DAY 137			DAY 138			DAY 139			DAY 140		
TYPE	EVENT	HRS	TYPE	EVENT	HRS	TYPE	EVENT	HRS	TYPE	EVENT	HRS	TYPE	EVENT	HRS
ICW	P24.055	2.0	ICW	P24.090	2.0	PTT 19	P24.112	2.0	ICW	P24.172	2.0	WTT 11	P24.190	6.0
CAI	P24.060	1.5	CAI	P24.100	1.5	PTT 20	P24.113	2.0	ICW	P24.175	2.0			
CAI	P24.065	1.5	PTT 18	P24.111	2.0	IGR	P24.115	2.0	CAI	P24.180	1.5			
CAI	P24.070	1.5				ICW	P24.170	2.0	ICW	P24.185	2.0			
TRAINING HOURS		6.5	TRAINING HOURS		5.5	TRAINING HOURS		8.0	TRAINING HOURS		7.5	TRAINING HOURS		6.0

Table 8. Category I FRP Syllabus Daily Planner (8 of 9)

WEEK TWENTY-NINE														
DAY 141			DAY 142			DAY 143			DAY 144			DAY 145		
TYPE	EVENT	HRS	TYPE	EVENT	HRS	TYPE	EVENT	HRS	TYPE	EVENT	HRS	TYPE	EVENT	HRS
WTT 12	P24.195	6.0	WTT 13	P24.200	6.0	WTT 14	P24.210	6.0	WTT 15	P24.215	6.0	TOFT 11	P24.220	6.0
			PPT	P24.205	1.5									
TRAINING HOURS		6.0	TRAINING HOURS		7.5	TRAINING HOURS		6.0	TRAINING HOURS		6.0	TRAINING HOURS		6.0

WEEK THIRTY														
DAY 146			DAY 147			DAY 148			DAY 149			DAY 150		
TYPE	EVENT	HRS	TYPE	EVENT	HRS	TYPE	EVENT	HRS	TYPE	EVENT	HRS	TYPE	EVENT	HRS
ICW	P24.225	2.0	PTT 21	P24.250	2.0	ICW	P24.310	2.0	WTT 16	P24.340	6.0	TOFT 12	P24.345	6.0
ICW	P24.230	2.0	ICW	P24.270	2.0	ICW	P24.320	2.0						
CAI	P24.240	1.5	ICW	P24.300	2.0	ICW	P24.330	2.0						
						IGR	P24.335	2.0						
TRAINING HOURS		5.5	TRAINING HOURS		6.0	TRAINING HOURS		8.0	TRAINING HOURS		6.0	TRAINING HOURS		6.0

WEEK THIRTY-ONE														
DAY 151			DAY 152			DAY 153			DAY 154			DAY 155		
TYPE	EVENT	HRS	TYPE	EVENT	HRS	TYPE	EVENT	HRS	TYPE	EVENT	HRS	TYPE	EVENT	HRS
TOFT 13	P24.350	6.0	ICW	P24.365	2.0	TOFT 14	P24.420	6.0	TAC 7	P24.440	5.0	ICW	P25.010	2.0
			ICW	P24.370	2.0							ICW	P25.030	2.0
			IGR	P24.410	2.0							CAI	P25.020	1.5
TRAINING HOURS		6.0	TRAINING HOURS		6.0	TRAINING HOURS		6.0	TRAINING HOURS		5.0	TRAINING HOURS		5.5

WEEK THIRTY-TWO														
DAY 156			DAY 157			DAY 158			DAY 159			DAY 160		
TYPE	EVENT	HRS	TYPE	EVENT	HRS	TYPE	EVENT	HRS	TYPE	EVENT	HRS	TYPE	EVENT	HRS
ICW	P25.050	2.0	TOFT 15	P25.085	6.0	TOFT 16	P25.090	6.0	ICW	P25.100	2.0	IGR	P25.130	2.0
CAI	P25.060	1.5							ICW	P25.110	2.0	EXAM	P25.135	1.0
ICW	P25.080	2.0							ICW	P25.120	2.0			
TRAINING HOURS		5.5	TRAINING HOURS		6.0	TRAINING HOURS		6.0	TRAINING HOURS		6.0	TRAINING HOURS		3.0

Table 9. Category I FRP Syllabus Daily Planner (9 of 9)

WEEK THIRTY-THREE														
DAY 161			DAY 162			DAY 163			DAY 164					
TYPE	EVENT	HRS	TYPE	EVENT	HRS	TYPE	EVENT	HRS	TYPE	EVENT	HRS	TYPE	EVENT	HRS
TOFT 17	P25.140	6.0	TAC 8	P25.156	5.0	TOFT 18X	P25.150	6.0	OFT 13	P25.155	6.0			
									CRT	P25.160	0.5			
TRAINING HOURS		6.0	TRAINING HOURS		5.0	TRAINING HOURS		6.0	TRAINING HOURS		6.5	TRAINING HOURS		0.0

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