Proceedings of the 2020 Annual General Donald R. Keith Memorial Capstone Conference
West Point, New York, USA
April 30, 2020
A Regional Conference of the Society for Industrial and Systems Engineering

B-kit Management Paradigm Simulation

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Author Note: Cadets Murdock, Agsalud, Wright, and Cliborne are senior West Point cadets in the Department of Systems Engineering. LTC Brandon Thompson has served as faculty advisor to the cadet capstone team. The team would like to recognize the Project Management office for Aircraft Survivability Equipment (PM ASE), the Department of the Army Military Operations - Aviation (DAMO-AV), and the United States Military Academy Department of Systems Engineering for facilitating this study. All four contributing cadets will commission into Army Aviation.

Abstract: The United States Army's rotary-wing fleet must undergo comprehensive modernization of Aircraft Survivability Equipment (ASE) to combat emerging threats from advanced generation Man-Portable Air Defense Systems (MANPADS). A crucial part of this modernization is installing the physical sensors, known as B-kits, prior to deployment to operational assignments. Effective B-kit management accounts for production rate, quantity available, costs, and available installation windows. This project is aimed at developing an optimal B-kit management strategy to manage these constraints and maximize Army Aviation readiness while maintaining minimal impact to operational tempo, training cycles, and unit operations. A discrete event simulation was leveraged to identify an optimal B-kit management plan. The model simulated a range of B-kit installation scenarios templated on each Combat Aviation Brigade's existing training schedule and evaluated readiness metrics based upon user inputs pertaining to desired pre-deployment "no-touch" training windows. The model provided policy makers with the tools necessary to reorient ASE modernization doctrine to achieve the personnel staffing, A-kit/B-kit supply, and funding requirements needed to achieve readiness levels required to combat existing and emerging threats and alleviate the existing Joint Urgent Operational Need Statement (JUONS).

Keywords: Aircraft Survivability Equipment, Army Aviation, Man Portable Air Defense System, Discrete Event Simulation

1. Project Motivation

The U.S. Army's rotary-wing fleet identified a need to undergo comprehensive modernization of Aircraft Survivability Equipment (ASE). This was a result of aging Joint-Urgent Operational Need Statement (JUONS) solutions fielded in the early 2000s to address increased MANPADS threats in the Global War on Terrorism (GWOT). Technologically advanced, or near-peer, forces threaten to out-pace existing ASE and require the creation of a timely modification campaign. The stakeholders invested in this project are the Project Management Office for Aircraft Survivability Equipment (PM-ASE), Army G-3/5/7, Army G-8, Department of the Army Military Operations - Aviation (DAMO-AV), the U.S. Army Forces Command (FORSCOM), and the operational aviation community. Cadet involvement with the project began with a three-week advanced individual academic development internship at PM ASE completed by one of the cadet team members. After deciding to maintain cadet involvement through a capstone, the cadet led project's purpose was to develop a flexible and adaptable simulation of B-kit installations for the entire rotary-wing fleet.

2. Background

Advanced generation MANPADs have become progressively more prevalent on the modern battlefield since the 1980's. American support of the Mujahideen during the Soviet invasion of Afghanistan led to large quantities of unaccounted MANPADs being dispersed amongst local municipalities. The collapse of the Soviet Union led to the mismanaged liquidation of Soviet Bloc state's military arsenals which saturated illicit weapons markets with advanced MANPAD technologies as well. The aggregate effect of these events is that MANPADS have become a legitimate threat to coalition forces in combat theaters. The Global War on Terrorism and wars in Iraq and Afghanistan revealed that current ASE was effective against line-of-sight weaponry. Existing aircraft TTPs and ASE such as flares and chafe were able to mitigate risk from rocket propelled grenades, large caliber machine guns, and small arms fire; however, existing ASE quickly became ill-suited for advanced generation

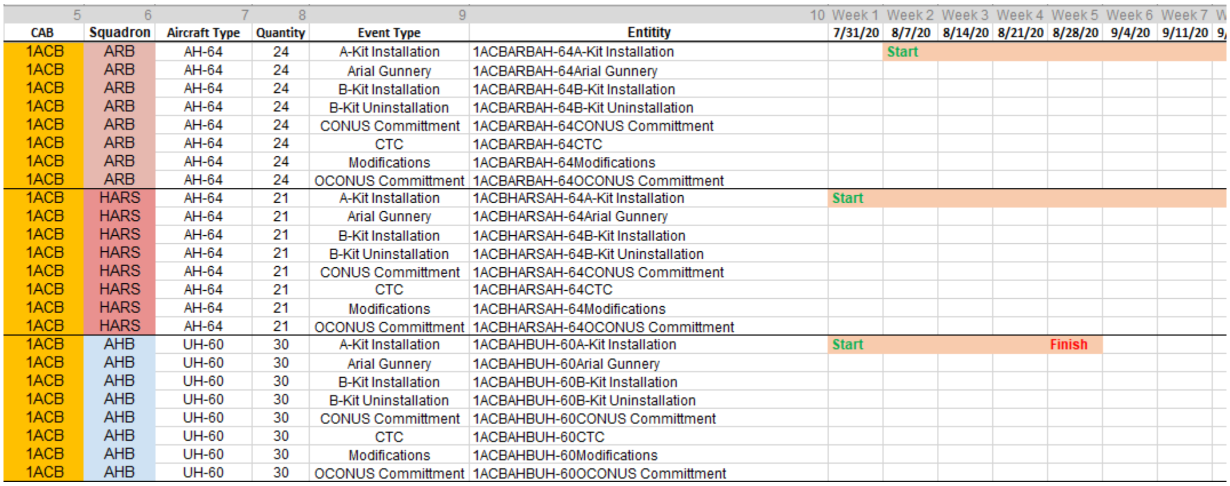
MANPADS which targeted an aircraft's heat signature and were immune to flares and chafe. Faced with a troubling technology gap, our project aimed to develop a novel modernization paradigm designed to rapidly outfit the Army's rotary-wing fleet with state-of-the-art ASE in the most efficient manner without unnecessary degradation of unit readiness. The modernization paradigm is centered around the installation of a universal A-kit (interface) across the entire fleet, followed by the "as-needed" installation of multiple B-kit (sensor plug-ins) variants prior to OCONUS deployments. The A-kit refers to the wiring package that must be installed to create a universal interface on each aircraft. Installing A-kits is the precedent for installing any other ASE. The B-kit refers to the physical sensors and components plugged into the A-kit that enable the pilot to interface with the systems. The current modification package consists of the Limited Interim Missile Warning System (LIMWS), and the Common Infrared Countermeasure (CIRCM). The Common Missile Warning System (CMWS) is the legacy system, which is being replaced by the more advanced LIMWS, but remains compatible with CIRCM and the universal A-kit. In the event that LIMWS installation requirements outpace LIMWS production rates, CMWS can be installed at the expense of marginal readiness reductions. PM ASE's current modernization paradigm features an A-kit installation schedule which installs A-kits to each combat aviation brigade (CAB) sequentially, and spans more than a decade. Following A-kit installation, PM ASE lacked a B-kit management strategy to dictate the installation of B-kits across the fleet. PM ASE and FORSCOM stated that B-kit installation should follow an "As Late As Possible" logic, with B-kit installation occurring at home station as close to the deployment date as possible. Early B-kit installation created a prolonged exposure of the B-kit sensors to training environments with high damage risk. B-kit management was constrained foremost by the A-kit installation timeline. Once A-kits are installed across a CAB, B-kit installation is constrained by the immediacy of an OCONUS deployment, the production rate and available store of CIRCM and LIWMS B-kits, the availability of Aviation Field Maintenance Director (AFMD) contractors, hangar bay availability, and the CAB's existing training cycle. PM ASE and FORSCOM desired a simulation medium to conduct complex scenario analysis of multiple B-kit management paradigms. The USMA Capstone team selected ProModel as the optimal discrete simulation software for developing a B-kit management paradigm simulation due to the team's previous ProModel experience and ProModel's previous application to a similar BOG-Dwell optimization study.

3. Methodology

The goal of this project was to provide PM-ASE and FORSCOM with a viable model that enables Army Aviation to create an optimal B-kit management plan through rigorous scenario analysis. This goal was accomplished in four distinct phases – stakeholder analysis, model construction, scenario analysis, and policy recommendations. Developing a coherent project scope required iterative stakeholder analysis. PM ASE, FORSCOM, Army G-3/5/7, and DAMO-AV each had competing and congruent interests in the development of a B-kit management simulation. The agile project management process was used to formulate several iterations of project scope before all stakeholder interests were satisfied. Once the project scope satisfied the stakeholders, data collection began. The project team consulted with representatives of PM-ASE, the Aviation Field Maintenance Directorate, and FORSCOM to collect relevant data. PM-ASE provided the team with detailed information pertaining to the manufacturing rates, installation durations, and performance metrics for A-kits and CIRCM, LIMWS, and CMWS B-kits. The modernization of the 1st Air Cavalry Brigade is currently being managed by AFMD, which provided the project team with real-time data used to validate the hypothetical installation metrics supplied by PM-ASE. FORSCOM and G3/5/7 collaborated to provide the project team with a four-year fleet training schedule that was representative of the CAB Patch chart (U.S. Army unit training schedule). The project team worked with a contact from ProModel to gain an understanding of ProModel's capabilities to model a system of this level of complexity. The ProModel representative assisted the project team in identifying key metrics necessary to begin constructing a model. These metrics focused on the composition of each CAB (aircraft number by type, personnel numbers, unit hierarchy), the installation rates for each B-kit, the manufacturing costs, and the A-kit installation timeline. The stakeholders required that the model was capable of accepting a multi-CAB, multi-year training calendar capturing all relevant training events, CONUS and OCONUS commitments, maintenance cycles, and CTC rotations. The stakeholders also required that the model be flexible to allow battalion/squadron commanders and higher to edit their respective unit's training schedule, hangar space availability, personnel availability, and desired pre-deployment readiness goals/deadlines.

4. Model Creation

After consulting with a ProModel representative, the team gathered all performance and installation metrics required to model each CAB and the A-kit/B-kit installation process; however, a significant challenge emerged regarding the CAB training calendar input. ProModel requires that data array inputs be structured as row/column matrices, preferably with binary or base-10 cell values. This posed a significant challenge when attempting to translate the provided Patch chart into a viable model input. The solution was to generate a spreadsheet which depicted each squadron of each CAB in consecutive rows (Figure 1). Accompanying each squadron's unique unit ID row was a collection of rows in the adjacent column listing each type of training event that the Squadron could be involved with such as aerial gunnery, CTC rotations, A-kit installation, B-kit installation, and OCONUS/CONUS commitments. Traversing across the spreadsheet, each row represented a single calendar week spanning from FY20 to FY31. Using "Start" and "Finish" inputs, the team dissected the Patch chart into each individual squadron of each CAB and translated each squadron's respective training schedule into the appropriate row/column representing the respective training event and its respective "Start" and "Finish" week. The granularity of the model was limited to the battalion/squadron level because each squadron, except the General Support Aviation Battalion, was homogenous in the type of airframe it operated, and the stakeholder was not concerned with the status of individual tail numbers. The GSAB was modeled as two separate units, one operating the HH/UH-60 and the other operating the CH-47. Once ProModel accepted the fleet training calendar, the simulation would traverse across the calendar matrix and change the state of each Squadron entity based upon its training status. When a squadron completed A-kit installation, an attribute was assigned to the respective squadron showing that the aircraft were now A-kit equipped. When a squadron entered a training event such as gunnery, CTC, maintenance, or OCONUS/CONUS commitments, a temporary attribute would be assigned to the squadron that marked the unit as unavailable for simultaneous actions, such as B-kit installation. The simulation was constructed to monitor each squadron's A-kit status in relation to upcoming OCONUS commitments. Once a squadron became A-kit equipped, the simulation would begin scanning a preset (adjustable as an input) number of weeks into the future training calendar to identify an impending OCONUS deployment. If an OCONUS deployment was identified within that preset window of time, B-kit installation would be triggered and overlaid on the existing training schedule. If B-kit installation conflicted with existing training events, the model would pause B-kit installation for the duration of the training event and resume installation afterwards. If an OCONUS deployment was not templated within the preset scanning window, the model would continue traversing the training matrix until a deployment was identified. Following an OCONUS deployment, B-kit removal was initiated based upon "As Soon As Possible" queuing logic. ProModel offers an adaptable output viewer that allows the user to view data in many graphical and numerical representations, such as time plots and histograms. The user interface (Figure 2) depicts the state of each CAB and squadron in real-time, with a squadron's task designator turning green when deployed OCONUS. Once a squadron is equipped with A-kits, a green "A" and checkmark appear next to the squadron ID. During B-kit installation, the percentage of aircraft equipped with B-kits is displayed below the "A-kit equipped" designator. At the bottom of the interface, there are four counters which track the real-time status of LIMWS, CMWS, and CIRCM stockpiles and the number of kits in transit from the manufacturing facility to the CAB home station. The readiness counter located below each CAB tracks the CAB-wide readiness at the start of a deployment, defined as the percentage of aircraft equipped with both B-kits. In addition to the user interface and ProModel's in-house output viewer, our team collaborated with the ProModel representative to link simulation outputs with an output excel file (Figure 3). The output excel file is a color-coded log which depicts the fleet training calendar based upon the simulation results. It provides the user with an output resembling a Patch chart that depicts when optimal B-kit installation is templated given the user's input parameters. Regarding input parameters, the model was designed to allow battalion/squadron commanders and above the ability to edit model parameters to conduct scenario analysis. The model features editable macros that allow the user to modify the following parameters: (1) unit training cycle, (2) unit MTOE for aircraft, (3) number of work days per week, (4) number of hours per work day, (5) personnel requirements for B-kit install, (6) number of available AFMD contractors, (7) installation and production rate of B-kits, (9) the number of weeks the model scans into the future looking for a deployment, and (10) a commander's desired "no-touch" window. The "no-touch" window refers to a period prior to a deployment when the commander desires all aircraft and equipment to be conducting pre-deployment train-up rather than being occupied by maintenance. The model will output a snapshot of unit readiness at the prescribed "no touch" window to tell the commander whether the pre-deployment training window was preserved or degraded by B-kit installations. Altering the simulation macros and input matrices allows the user to conduct scenario analysis of varying complexity. The training calendar input matrix can be adjusted to depict varying operational tempos, increased maintenance capabilities and modernization rates, surge-style deployments, or potential near peer conflicts. Analysis of the output log and ProModel output viewer allows for identification of backlogs and limiting factors which degrade unit and fleet readiness in varying scenarios. From these conclusions, policy recommendations can be made regarding the appropriation of funds, alteration of modernization paradigms, and allocation of personnel and resources to optimize modernization efforts.



5	6	7	8	9	10	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	W
CAB	Squadron	Aircraft Type	Quantity	Event Type	Entitity	7/31/20	8/7/20	8/14/20	8/21/20	8/28/20	9/4/20	9/11/20	9/
1ACB	ARB	AH-64	24	A-Kit Installation	1ACBARBAH-64A-Kit Installation		Start						
1ACB	ARB	AH-64	24	Arial Gunnery	1ACBARBAH-64Arial Gunnery								
1ACB	ARB	AH-64	24	B-Kit Installation	1ACBARBAH-64B-Kit Installation								
1ACB	ARB	AH-64	24	B-Kit Uninstallation	1ACBARBAH-64B-Kit Uninstallation								
1ACB	ARB	AH-64	24	CONUS Committment	1ACBARBAH-64CONUS Committment								
1ACB	ARB	AH-64	24	CTC	1ACBARBAH-64CTC								
1ACB	ARB	AH-64	24	Modifications	1ACBARBAH-64Modifications								
1ACB	ARB	AH-64	24	OCONUS Committment	1ACBARBAH-64OCONUS Committment								
1ACB	HARS	AH-64	21	A-Kit Installation	1ACBHARSAH-64A-Kit Installation	Start							
1ACB	HARS	AH-64	21	Arial Gunnery	1ACBHARSAH-64Arial Gunnery								
1ACB	HARS	AH-64	21	B-Kit Installation	1ACBHARSAH-64B-Kit Installation								
1ACB	HARS	AH-64	21	B-Kit Uninstallation	1ACBHARSAH-64B-Kit Uninstallation								
1ACB	HARS	AH-64	21	CONUS Committment	1ACBHARSAH-64CONUS Committment								
1ACB	HARS	AH-64	21	CTC	1ACBHARSAH-64CTC								
1ACB	HARS	AH-64	21	Modifications	1ACBHARSAH-64Modifications								
1ACB	HARS	AH-64	21	OCONUS Committment	1ACBHARSAH-64OCONUS Committment								
1ACB	AHB	UH-60	30	A-Kit Installation	1ACBAHBUH-60A-Kit Installation	Start				Finish			
1ACB	AHB	UH-60	30	Arial Gunnery	1ACBAHBUH-60Arial Gunnery								
1ACB	AHB	UH-60	30	B-Kit Installation	1ACBAHBUH-60B-Kit Installation								
1ACB	AHB	UH-60	30	B-Kit Uninstallation	1ACBAHBUH-60B-Kit Uninstallation								
1ACB	AHB	UH-60	30	CONUS Committment	1ACBAHBUH-60CONUS Committment								
1ACB	AHB	UH-60	30	CTC	1ACBAHBUH-60CTC								
1ACB	AHB	UH-60	30	Modifications	1ACBAHBUH-60Modifications								
1ACB	AHB	UH-60	30	OCONUS Committment	1ACBAHBUH-60OCONUS Committment								

Figure 1. Model Input Matrix

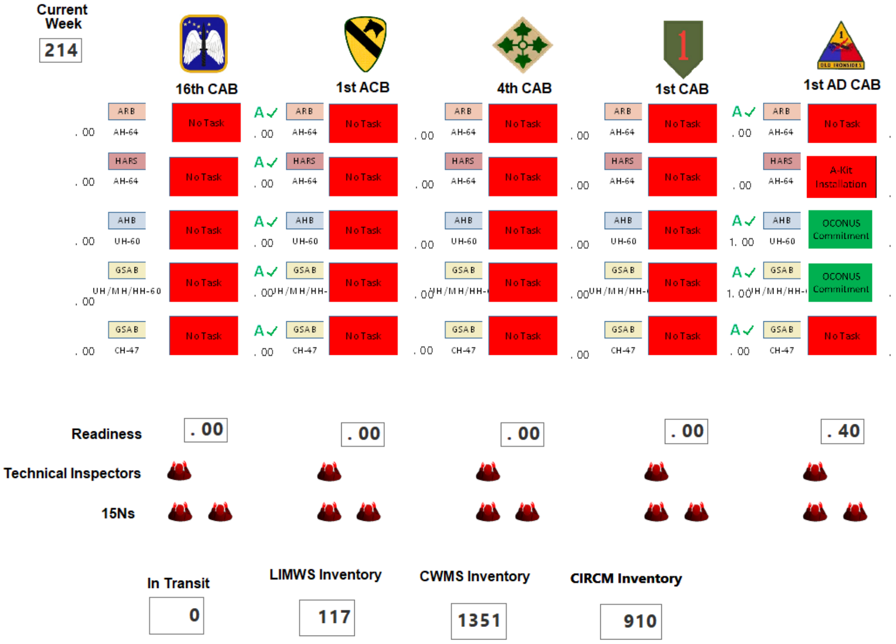
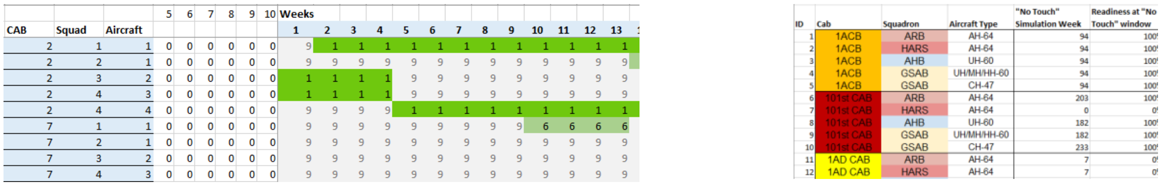


Figure 2. Snapshot of B-kit Management User Interface

5. Scenario Analysis and Policy Recommendation

The purpose of this project was to provide PM ASE and FORSCOM with a discrete simulation tool to guide modernization policy recommendations. After constructing the ProModel simulation, the team validated the model through logic tracing of the entities, resources, processes, arrival events, and macros. The team verified the model by comparing metrics of the model's prescribed B-kit installation timeline with performance metrics from AFMD's test installations which occurred during 1st Air Cavalry Brigade's (1ACB) ongoing modernization efforts. The first scenario that our team analyzed was the existing modernization paradigm (Figure 3). This paradigm templated A-kit installations sequentially, starting with 1ACB and moving to a new CAB every ~1.5 years. The team's preliminary concerns were that the A-kit installation would pose as a significant limiting factor, delaying the installation of B-kits across the fleet. Driving the current paradigm was a shortage of A-kits, a slow manufacturing rate, and limited financial appropriations available to increase production rate and personnel allocations. Our team was interested in analyzing the performance of the current modernization paradigm if surge-style and near-peer conflicts emerged.



			5	6	7	8	9	10	Weeks												
CAB	Squad	Aircraft							1	2	3	4	5	6	7	8	9	10	11	12	13
2	1	1	0	0	0	0	0	0	9	1	1	1	1	1	1	1	1	1	1	1	1
2	2	1	0	0	0	0	0	0	9	9	9	9	9	9	9	9	9	9	9	9	9
2	3	2	0	0	0	0	0	0	1	1	1	1	9	9	9	9	9	9	9	9	9
2	4	3	0	0	0	0	0	0	1	1	1	1	9	9	9	9	9	9	9	9	9
2	4	4	0	0	0	0	0	0	9	9	9	9	1	1	1	1	1	1	1	1	1
7	1	1	0	0	0	0	0	0	9	9	9	9	9	9	9	9	9	6	6	6	6
7	2	1	0	0	0	0	0	0	9	9	9	9	9	9	9	9	9	9	9	9	9
7	3	2	0	0	0	0	0	0	9	9	9	9	9	9	9	9	9	9	9	9	9
7	4	3	0	0	0	0	0	0	9	9	9	9	9	9	9	9	9	9	9	9	9

ID	Cab	Squadron	Aircraft Type	"No Touch" Simulation Week	Readiness at "No Touch" window
1	1ACB	ARB	AH-64	94	100
2	1ACB	HARS	AH-64	94	100
3	1ACB	AHB	UH-60	94	100
4	1ACB	GSAB	UH/MH/HH-60	94	100
5	1ACB	GSAB	CH-47	94	100
6	101st CAB	ARB	AH-64	203	100
7	101st CAB	HARS	AH-64	0	0
8	101st CAB	AHB	UH-60	182	100
9	101st CAB	GSAB	UH/MH/HH-60	182	100
10	101st CAB	GSAB	CH-47	233	100
11	1AD CAB	ARB	AH-64	7	0
12	1AD CAB	HARS	AH-64	7	0

Figure 3. Snapshot of Output Log – Training Calendar/Event Tracking (left) and Readiness Date (right)

In a surge-style conflict scenario, an emerging conflict or enemy offensive would necessitate the rapid deployment of a large force, similar to the surge in Iraq in 2007. A surge-style scenario would necessitate multiple CABs to be deployed on short notice. In the context of our model, the team altered the CAB input file to reflect a multi-CAB OCONUS commitment in the vicinity of week 170, the beginning of FY24. At this point in time, 1ACB, 101st CAB, and portions of 1 AD CAB were outfitted with A-kits. Although other CABs were available for deployment at this time, less than three full CABs were available to deploy with the modern ASE package. The most troubling observation rested in the B-kit installation process. Currently, B-kits are produced at a rate of 15 CIRCM and 4 LIMWS per month due to funding and manufacturing limitations. This manufacturing rate can handle temporally spaced-out OCONUS commitments because the long lulls between CAB level B-kit installations allows stockpiles of B-kits to amass; however, the surge-style scenario necessitates that B-kits are installed across multiple CABs simultaneously. In this scenario, the B-kit installation rate outpaces the manufacturing rate and depletes the B-kit stores. This supply and demand gap degraded the CAB's readiness rate at the commander's prescribed "no touch" window as well as the start of the deployment. Competition for scarce resources led CABs to deploy with large quantities of partially equipped or unequipped aircraft.

In the near-peer conflict, the input matrix is configured similar to the surge-style conflict in that a multi-CAB OCONUS commitment is templated on the fleet training calendar. In the case of a near-peer conflict, it is assumed that FORSCOM has an enhanced ability to forecast a conflict of such significant magnitude, therefore CABs are warned of the impending commitment further in advance. This was modeled in our simulation by increasing the window by which the model scans the time horizon for impending OCONUS commitments. Our team's first observation was that the A-kit installation timeline was once again the dominant limiting factor. The sequential A-kit installation paradigm required 1.5-2 years to complete A-kit installations for a single CAB. The driving factor for this slow installation rate was limited personnel and resource availability due to inadequate financial appropriation. The sequential A-kit installation prevented the model from staffing a near-peer conflict with modernized CABs because too few CABs had been able to install B-kits by virtue of not having A-kits installed. Furthermore, the low production rate of CIRCM and LIMWS B-kits was still outpaced by installation rates, even in situations where multiple CABs had the time to install B-kits in close succession rather than simultaneously. The absence of a lull between deployments prevented adequate stores of B-kits from being amassed.

In both surge-style and near-peer conflict scenarios, the personnel numbers, work week length, and workday duration were not observed to be limiting factors. The dominant limiting factor in both scenarios were the A-kit installation timeline (constrained by manufacturing capacity dictated by financial appropriation) and B-kit manufacturing rate (constrained by manufacturing capacity dictated by financial appropriation). These observations lead our team to test a third scenario in which A-kit manufacturing rate was unlimited and two CABs could be equipped with A-kits simultaneously. This was accomplished by shifting the a-kit installation windows for squadrons within the input matrix to overlap within two CABs. The resulting simulation produced a CAB training calendar in which twice as many CABs were A-kit equipped by FY24, providing five CABs to respond to the surge-style scenario. Moreover, the simultaneous A-kit installation scenario suggested that the increased CAB down time between dual-CAB A-kit installs provided the necessary lull in manufacturing to boost personnel and financial appropriations to B-kit manufacturing. This allowed the B-kit stores to absorb the rapid succession of B-kit installs accompanying a near-peer conflict more effectively.

The implication of the surge-style and near-peer conflict scenarios are that Army Aviation will not be prepared to equip and fulfill the necessary force requirements to combat a surge or near-peer threat in the next 5-6 years. This conclusion is driven by the A-kit install timeline. Although CABs can continue to deploy without adequate ASE, there vulnerability to 1st-4th generation MANPADS will pose a persistent risk to the lives of pilots and crewmembers. The emergence of MANPADS is trending upwards around the globe and the availability and ease-of-use associated with these weapons systems has allowed non-conventional, insurgency style forces to acquire and engage coalition forces with increased regularity and effectiveness.

The prioritization of ASE modernization efforts necessitates a reallocation of funds and resources to enhance A-kit/B-kit production rates. Otherwise, the rotary wing fleet remains at risk for suffering catastrophic battlefield losses before TTPs and existing manufacturing capabilities can equip the entire fleet.

Regarding policy recommendations, our model has revealed the dominant limiting factor to be the A-kit manufacturing and installation rate. Our team recommends a comprehensive review of A-kit manufacturing strategies aimed at increasing the manufacturing rate to handle dual-CAB simultaneous installations. Combined with increased AFMD personnel allocations, the A-kit installation timeline can be reduced to from ten years to six years. This would allow more units to be available for B-kit installation and allow FORSCOM the freedom of maneuver to alter future Patch charts to align A-kit/B-kit equipped CABs with combat theaters where advanced generation MANPADS are present, while aligning non-equipped CABs to rotations in EUCOM or PACOM theaters. Another policy recommendation relates to acceptable standards of readiness. The recommended overhaul of A-kit installation and funding presents a significant challenge considering the complexities of defense spending and appropriations. Another method of producing a more uniformly modernized fleet rests in commander's accepting less than 100% readiness within their unit entering a deployment. While modeling the surge scenario, our team observed that two CABs were able to reach 100% B-kit readiness, while a third CAB achieved 50% readiness. Rather than deploying in this configuration, an alternative solution would have been to distribute some B-kits from 1ACB and 101st CAB to 1 AD CAB in order to deploy with three CAB nearing 90% readiness. This scenario can be expanded to instances where B-kit manufacturing is overloaded. Rather than deploying two CABs with 100% readiness and two CABs with 0% readiness, commanders can transfer ASE between units in order to deploy with four CABs exhibiting 50% ASE readiness. While deployed, AFMD personnel and contracted maintainers could be on-hand to transfer B-kits and reconfigure other ASE amongst aircraft to protect whichever aircraft are currently mission capable.

Through this project, our team produced a viable prototype for a B-kit management simulation. The model satisfied the stakeholder's requirements for data input capabilities and output mediums. The model was designed to grant stakeholders the freedom to edit and update unit MTOE's, personnel availability, manufacturing and installation rates, and training schedules to reflect desired scenarios or the evolving patch chart. Future adaptations to the model could account for B-kit emulators to supplement pre-deployment training and cockpit familiarization during CTC rotations. B-kit emulators are systems that can be rapidly installed into an aircraft's flight computer that can mimic the responses of real B-kits to environment stimulus. This would allow pilots to train against augmented/simulated threats without requiring B-kits to be installed. By incorporating B-kit emulators into this simulation, the pre-deployment no-touch window could be reduced or eliminated. Additionally, future adaptations of the model could increase the ease-of-use of the data input matrix. Currently, a unit's training schedule must be translated manually from a unit training calendar or the path chart. This process is tedious and carries the potential for making erroneous inputs. An enhanced input form or database with error-message feedback would improve user experience. Lastly, the model could be improved by increasing its granularity beyond the battalion/squadron level and week time increment, extending down to individual tail numbers and daily operations. This increased granularity would provide commanders with accurate insight into the availability of each aircraft and crew during modernization efforts.

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