ARFORGEN BOG:Dwell Simulation

MAJ David W. Hughes, M.S.
Lead Analyst, Operations Research Center

MAJ Mark M. Zais, M.S.
Lead Analyst, Army G1, Military Strength Analysis & Forecasting

LTC Paul Kucik, Ph.D.
Director, Operations Research Center

COL Fernando M. Huerta, M.S
Chief, Army G1, Military Strength Analysis & Forecasting

Sponsored by
U.S. Army G1, Military Strength Analysis & Forecasting

Operations Research Center of Excellence
West Point, NY 10996
July 2011

ORCEN Technical Report: DSE-TR-1101
DTIC: ADA544682

Executive Summary

The Army refers to the time a Soldier spends deployed overseas in a combat environment as Boots on the Ground time, or BOG. Conversely, the time a Soldier spends between deployments is known as "dwell." This BOG:Dwell ratio is an important, highly visible statistic, that serves as a leading indicator of recruiting, retention, and morale issues for the Army, its Soldiers, and their families.

In 2009, the VCSA designated BOG:Dwell analysis as a priority modeling effort because he recognized how much stress was being placed on the force and wanted to know which type of Soldiers were the most stressed. He heard stories of young Soldiers who spent nearly 50% of their time in service deployed in support of on-going operations. So impacted by these stories, he wanted to know if there was anything he could do (such as further restructuring the Army or changing policy) that would have positive effects on the Army and its Soldiers.

Problem Definition The Army G1's Strength Analysis and Forecasting Division in the Plans and Resources Directorate (PRS) and the Department of Systems Engineering's Operations Research Center of Excellence (ORCEN) were tasked to expand the capability of the existing BOG:Dwell model to both estimate the individual dwell statistics by grade for many critical Military Occupational Specialties (MOSs) and produce other residual unit manning and individual attribute statistics. Additionally, this past year's efforts focused on improving the model so that it was more scalable, streamlined, and efficient.

Technical Approach We expanded the modeling capability to include the remaining Brigade Combat Team (BCT) centric Career Management Fields (CMFs), which are 13 (Field Artillery) and 19 (Armor). Additionally, we analyzed the Combat Aviation Brigade (CAB) centric MOSs, which include all specialties within CMF 15 (Aviation). Finally, and perhaps more importantly, we wanted to accomplish the critical task of incorporating the ability to model selected critical enabler MOSs, which included all MOSs within the following CMFs: 12 (Engineers), 25 (Signal), 31 (Military Police), 35 (Military Intelligence), and 89 (Explosive Ordnance Disposal). We presented the BOG:Dwell results in the form of a distribution to highlight statistical trends; however, if a single value was required, we still used the median dwell times for each MOS and grade to convey results to senior leaders and decision makers.

Results We ran a steady-state simulation for the CMFs mentioned above. We previously defined the steady-state as a 20-year analysis period starting on October 1, 2014 where (a) the AC Demand scenario is 1 Corps, 3 Divisions, 15 BCTs, 41K Enablers (normally represented as: 1/3/15/41K), (b) the standard deployment length is 1 year, (c) the RIP-TOA overlap is 25 days, and (d) the Army's authorized end strength is 463,398 Soldiers. After running the simulation, we analyzed the output data using the statistical software program MiniTab. Figure 1 compares dwell years by grade for the 11 (Infantry), 13 (Field Artillery), 15 (Aviation), and 19 (Armor) CMFs. Since all of the colored regions of the boxplots fall below the 2-year dwell line (shown in red), we can conclude that more than 75% of the Soldiers in these CMFs failed to experience a 1:2 BOG:Dwell ratio. In fact, only the 13 Series E7s and the E7s and E8s in the 19 Series have a significant portion of Soldiers getting 2 years of dwell (their upper whisker crosses over the 2-year dwell line). The lower enlisted Soldiers in the BCTs and CABs are not faring well at all. Specifically, in the BCTs, the dwell year medians for the skill level 1 (SL1) Soldiers (which equates to the E3s and E4s in our model) are all below the E6s, E7s, and E8s. Next, in Figure 2, we compared the 12 (Engineers), 25 (Signal), 31 (Military Police), 35 (Military Intelligence), and 89 (Explosive Ordnance Disposal) Series. These are five of the most critical enablers CMFs that the Army G1 wanted us to analyze. It is again clear to see that most Soldiers are not getting 2 years of dwell time. In fact, in each of these CMFs, the median for each grade falls below the red line. Also, only the E8s in the 31 and 35 Series have portions of their boxplot well over the 2-year dwell line. Additionally, the SL1s have lowest median dwell times in the 12, 25, 31, and 35 Series. Interestingly, the 89 Series SL1

has the highest median dwell time in its series. However, none of its upper whisker crosses the red line. So essentially, almost every SL1 in the 89 Series is failing to get 2 years of dwell time.

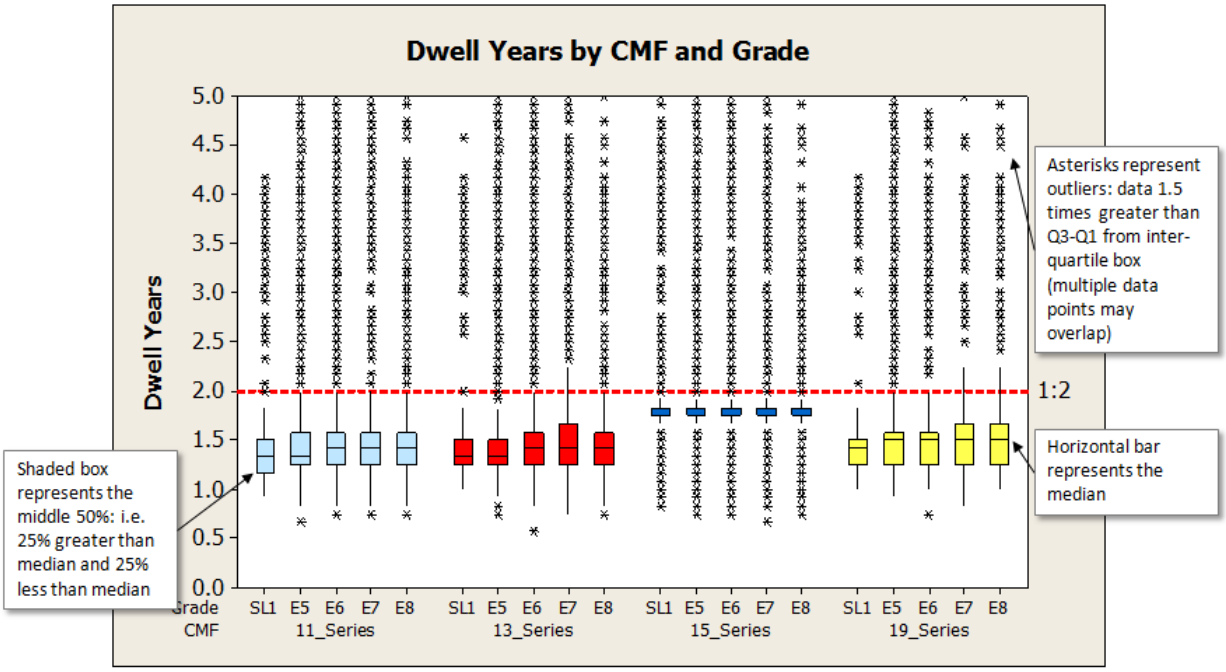


Figure 1: Dwell Year by CMF and Grade (11, 13, 15, and 19 Series)

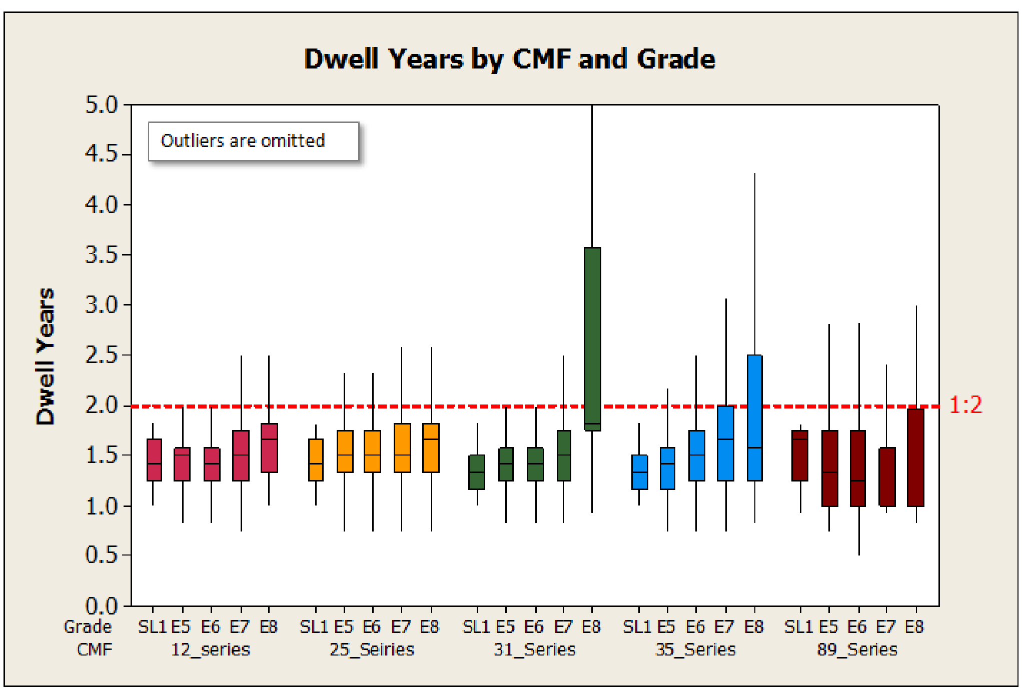


Figure 2: Dwell Year by CMF and Grade (12, 25, 31, 35, and 89 Series)

The more we show our model's capabilities to others, the more it generates widespread enthusiasm and support for a rigorous analysis of the Army's BOG:Dwell challenges. Predictably, with this awareness came additional requests for support. PRS already would like us to analyzed five more critical CMFs (42 - Administrative, 68 - Medical, 88 - Transportation, 91 - Maintenance, 92 - Supply & Logistics). Additionally, the 37th Chief of Staff of the Army would like us to look at the effects of shortening deployments to nine months and what impact that would have on BOG:Dwell ratios. Finally, we have been asked to study the effects of different demand scenarios so we can answer questions regarding whether our current force structure can handle higher demand. With just a few inputs (AST schedule, force structure of the Active Component Army, and current policies), there are a myriad of questions we can answer with our model.

One of our goals for 2011 model was to speed up the run time while adding the ability to analyze multiple, critical MOSs. With contracted programming support from ProModel, the simulation run time has been significantly reduced. The largest CMF (11 Series) can be simulated in less than 2 hours, which is 7% of the original run-time or a 1500% increase in speed.

The result of this research is a realistic and useable simulation tool that can assist decision makers in analyzing the future effects of current and proposed demand, structure, and policy changes. As the international environment changes, this tool will allow decision makers to design policy which complies with applicable regulations, law, and procedures and to understand the effect of that Army-level policy on the individual Soldier.

Acknowledgement

While their names do not explicitly appear on the cover page of this report, this study had many other critical supporters and analysts. Primary among these is the tireless, patient, and consummate professional Mr. Steve Courtney. A senior consultant with the ProModel Corporation, Steve has been absolutely fundamental as the architect of our simulation model, consistently performing well beyond our expectations. Additionally, Mr. Geno Laughridge of FORSCOM's AST program was a steadfast supporter of this effort, working extra hours on short or little notice to provide us with credible, realistic deployment schedules. Similarly, ProModel's Mr. Geoff Coleman ensured that we received the corporate assistance we needed from software to administrative support. Finally, last but not least, we thank LTC Paul Kucik (Director of West Point's ORCEN), and Mr. Gene Lesinski (ORCEN's XO) for painstakingly proofreading this report, providing sage guidance, and giving us the freedom to maneuver.

Administratively, this study was funded by the US Army G1 (Personnel) as part of a year-long effort in support of the Statement of Work entitled, "Army Personnel Management Modeling." The U.S. Government is authorized to reproduce and distribute reprints for governmental purposes notwithstanding any copyright annotation thereon. The views and conclusions herein are those of the authors and should not be interpreted as representing the official policies or endorsements, either expressed or implied, of the G1, USMA, or the U.S. Government.

Contents

1 INTRODUCTION

The Army refers to the time a Soldier spends deployed overseas in a combat environment as Boots on the Ground time, or BOG. Conversely, the time a Soldier spends between deployments is known as "dwell." This BOG:Dwell ratio is an important, highly visible statistic, that serves as a leading indicator of recruiting, retention, and morale issues for the Army, its Soldiers, and their families.

The restructuring of the active component to 45 Brigade Combat Teams (BCTs) and 13 Combat Aviation Brigades (CABs), along with the adoption of the Army Force Generation (ARFORGEN) process, have fundamentally changed Army force structure across rank and specialty while also transforming the model and cycle by which units are manned. In addition, the Global War on Terror (GWOT) has increased the importance of manning units to full strength while also placing significant burdens on Soldiers and families. In order to meet manning requirements for the planned force structure in support of potential conflicts worldwide, the Army G1 must constantly reassess the manning processes and policies used to achieve these goals. Thorough assessment of these policies has required modeling of the processes across the lifecycles of both units and individual Soldiers.

In 2009, the VCSA designated BOG:Dwell analysis as a priority modeling effort because he recognized how much stress was being placed on the force and wanted to know which type of Soldiers were the most stressed. He heard stories of young Soldiers who spent nearly 50% of their time in service deployed in support of on-going operations. So impacted by these stories, he wanted to know if there was anything he could do (such as further restructuring the Army or changing policy) that would have positive effects on the Army and its Soldiers.

2 BACKGROUND

Two years ago, MAJ Matt Dabkowski (from West Point's Operations Research Center of Excellence (ORCEN)) and MAJ Mark Zais (from the Army G1 Strength Analysis and Forecasting Division) started this project, initially focusing on what was considered the Career Management Field (CMF) with the highest density in BCTs, which was the 11 Series (Infantry). The Army wanted to meet its stated goal of giving Soldiers two years of dwell following a one year deployment. They referred to that goal as the ratio of Boots on the Ground (BOG) to dwell time, or BOG:Dwell. Stated another way, the Army's BOG:Dwell goal was 1:2. Back in the early 2000s, it was common place for key leaders and decision makers to look at unit BOG:Dwell ratios to see if they were meeting their stated goal. At the request of the Army's Human Resources Leadership, MAJ Dabkowski and MAJ Zais built a model (using ProModel © simulation software) to test the appropriateness of that practice. Their results are found in their technical report titled "Analysis of Unit and Individual BOG:Dwell in Steady-State ARFORGEN" dated 16 July 2009. Today's analysis of the effect of the Army Force Generation Process on the individual Soldier's BOG:Dwell ratio, draws from the initial model developed by the ORCEN and the Army G1. Recent efforts have been focused on improving the model so that it is more scalable, streamlined, and efficient. Ultimately, the desired end state is a simulation that is capable of both estimating the individual dwell statistics by grade for many critical Military Occupational Specialties (MOSs) and producing other residual unit manning and individual attribute statistics.

3 UNIT BOG:DWELL

MAJ Dabkowski and MAJ Zais's research found that unit dwell is not a sufficient proxy for individual Soldier dwell (Dabkowski et al., 2009). This is due to the fact that individual Soldiers do not stay with the same unit throughout their careers. Most change duty stations every 1-3 years whereas most units (certainly not all) were scheduled to deploy once every three years. So, if you have a unit deploying once in three years, the unit BOG:Dwell will be 1:2. But if a Soldier, coming off a one year dwell since their last deployment, gets stationed at a unit that just had two years of dwell and that is just about to begin a deployment, then that individual Soldier will have a BOG:Dwell of 1:1. Thus, it is fairly easy to see that unit dwell can be significantly longer than many of the Soldiers' individual dwell times. (Unit dwell can also be shorter than individual dwell. For example, since TDA units rarely deploy, if a Soldier moves from a TDA unit to a BCT, he may likely have an individual dwell statistic that is longer than the unit's.)

The latest version of the model still calculates unit dwell times based on output from Forces Command's (FORSCOM's) ARFORGEN Synchronization Tool (AST), which is a ProModel based discrete event simulation used by FORSCOM to determine the best sequencing of units into Iraq and Afghanistan, given the available information.

4 INDIVIDUAL BOG:DWELL

MAJ Dabkowski and MAJ Zais found that for the 11 Series, grade is a significant factor in individual Soldier dwell time (Dabkowski et al., 2009). Junior enlisted Soldiers often had worse BOG:Dwell statistics than more senior enlisted infantry Soldiers. They also convinced senior leadership that the median, instead of the average, was the most appropriate measurement of central tendency for the BOG:Dwell ratio (Dabkowski et al., 2009). This is due to the fact that outliers heavily skew averages and dwell statistics do not produce a symmetrical distribution.

Based upon their findings, we decided to expand the modeling capabilities to include the remaining Brigade Combat Team (BCT) centric CMFs, which are 13 (Field Artillery) and 19 (Armor). Additionally, we wanted to be able to analyze the Combat Aviation Brigade (CAB) centric MOSs, which include all specialties within CMF 15 (Aviation). Finally, and perhaps more importantly, we wanted to accomplish the critical task of incorporating the ability to model selected critical enabler MOSs. The first phase of selected enablers included all MOSs within the following CMFs: 12 (Engineers), 25 (Signal), 31 (Military Police), 35 (Military Intelligence), and 89 (Explosive Ordnance Disposal). As before, we determined that results presented in the form of a distribution are most effective for displaying statistical trends; however, if a single value was required, we still use the median dwell times for each MOS and grade to convey results to senior leaders and decision makers.

5 FUNCTIONAL DECOMPOSITION

We generated a simulated Army, assigned and deployed its Soldiers, and replicated their career progression in a manner similar to the original research conducted by MAJ Dabkowski and MAJ Zais. Thus, the functional decomposition found below is virtually unchanged (Dabkowski et al., 2009). Figure 3 is called an Integration Definition for Function Modeling Diagram (IDEF0).

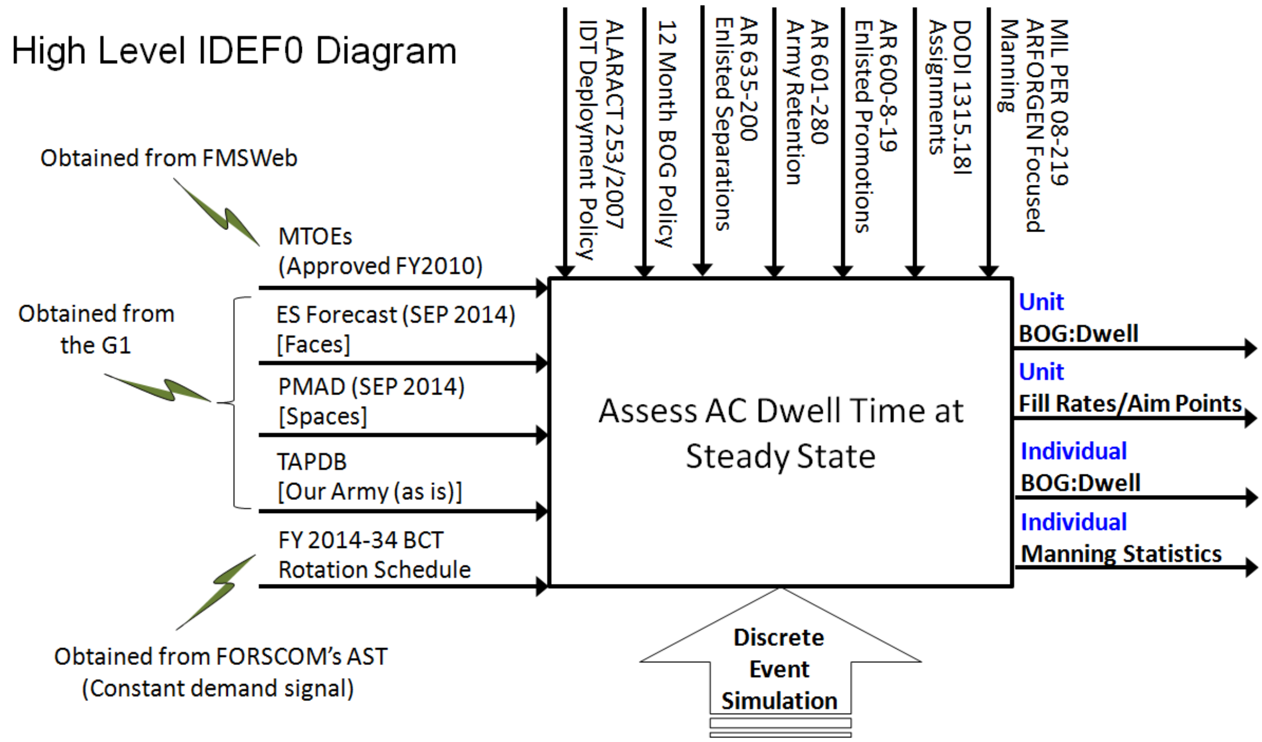


Figure 3: IDEF0 – Assessing Individual BOG:Dwell

5.1 Inputs

Represented by the arrows on the left side of Figure 3, the inputs to our model are as follows:

MTOEs: We decided to model the entire Army. Specifically, we built structure for BCTs, CABs, Headquarters units, TDA units, numerous supporting units, and an "Other" category to accommodate operational units that are not incorporated in the inputted ARFORGEN Synchronization deployment schedule. Requirements are disaggregated by grade, MOS, and location (Continental United States (CONUS), Outside the Continental United States (OCONUS), or Korea). In Table 1, you will find the types of units and quantities for the BCTs, the CABS, the Headquarters units, and 20 enabling units.

Table 1: Quantities of units by type.

QTY OF UNITs BY TYPE		QTY OF UNITs BY TYPE	
Type	Qty	Type	Qty
BCT HBCT	17	ADA BATTERY	6
BCT IBCT	20	ADA BN	9
BCT SBCT	8	MAMD BN	2
CAB Light	2	HHB ADA BDE	6
CAB Medium	6	SPACE DET	3
CAB Heavy	5	HHC MI BDE	5
HdQtrs CONUS	8	HHC MP BDE	5
HdQtrs OCONUS	1	FIN MGMT CTR	6
CHEM BDE	1	HR SUST CTR	4
CHEM BN	3	HR CO RECAP	6
ACQ CONTR BN	7	HHC EXPED SIGN BN	12
EOD CO	50	FIRES BDE	7
PUB AFF DET	14	HHC ENG BDE	6
		HHC MED BDE	4
		CORPS HQ	4

Each of these units has unique requirements for Soldiers by MOS and grade. To determine these manning requirements, we pulled the most recently approved FY2011 MTOEs for each type of unit using the Human Resources Command's (HRC's) web-enabled application known as Force Management System Website (FMSWeb).

Enlisted Strength Forecast (Faces): We estimated the Army's Operating Strength (OS), or faces, in the same way that MAJ Dabkowski and MAJ Zais forecasted the Army's future end strength by MOS and grade (Dabkowski et al., 2009). This forecasted strength by grade and MOS is generated by another Army G1 model called the Active Army Strength Forecaster (A2SF).

19,384	Col Ref	4	5	6	7	8	9	10
INDEX	MOS	E3	E4	E5	E6	E7	E8	E9
95	35F	1160	1160	1797	1362	749		
96	35G	258	393	313	296	150		
97	35L			418	328	328		
98	35M	447	901	750	744	315		
99	35N	601	600	734	537	350		
100	35P	286	329	585	566	380		
101	35S	149	293	304	238	116		
102	35T	3	305	131	167	91	26	13
103	35X						223	76
104	35Y						96	15
105	35Z						249	52

Figure 4: Enlisted Strength Forecast (35 Series)

Figure 4 presents an example of disaggregated requirements by grade for MOSs within CMF 35. In this case, the Army will have 19,384 Soldiers from the 35 Series available for assignment in September 2014.

Personnel Management Authorization Document (Spaces): Similar to the faces above, the Force Structure Allowance (FSA), or spaces, is the authorized positions for Soldiers by MOS and grade. Given the Personnel Management Authorization Document (PMAD), the FSA represents the approved structure for the Active Component. This is the structure that must be filled by the Army's OS (Dabkowski et al., 2009).

Table 2: 35 Series Roll-up.

Total Soldiers	*19,384*
Soldiers Authd	**19,262**
Not Authorized	*122*

As you can see from Table 2, the Army is authorized only 19,262 Soldiers from the 35 Series in September 2014. This means there are 122 excess Soldiers in the 35 Series.

Total Army Personnel Databases (Attributes): To model the characteristics or attributes of the Soldiers, we sampled from the Total Army Personnel Database (TAPDB) with replacement (Dabkowski et al., 2009). Therefore, each Soldier that is created is randomly assigned a set of attributes (Time on Station, Time in Grade, Contract Type, Month to ETS, and Time in Service) from samples of historical data from a selected period of time. Attribute data can be sampled from the most recent month of history or any month preceding. The importance of applying samples of historical attribute data to simulation entities during initiation is that it prevents us from having to mature the attributes of the initial Soldiers and allows us to bypass a lengthy warm-up period at the beginning of the simulation.

Table 3: Shows a small example of attributes randomly assigned to E3 Soldiers in CMF 35.

MOS INDEX	Grade	TOS (Mo)	TIG (Mo)	Contract (Type)	Months to ETS	TIS (Mo)
95	3	5	1	1	43	0
95	3	35	2	1	42	1
95	3	32	3	1	7	41
95	3	35	5	1	26	35
95	3	8	8	1	35	8
95	3	3	4	1	52	3
95	3	34	7	1	15	34
95	3	24	12	1	74	24
95	3	14	15	1	29	14
95	3	2	3	1	41	2
95	3	14	1	1	55	0
95	3	16	5	1	39	16
95	3	14	2	1	42	1
95	3	15	16	1	40	15
95	3	17	8	1	27	17
95	3	36	7	2	46	36
95	3	23	11	1	46	23

Rotation Schedule: FORSCOM provides an AST schedule which allows us to simulate ARFORGEN deployments. The output from FORSCOM's AST (Figure 5) provides us with the critical Latest Arrival Date (LAD) and Return (R) date for each rotating unit during our 20-year analysis period. From the LAD and R, we are able to determine all other dates, like LAD-90 and R+90.

RAW DATA - OUTPUT FROM AST - Updated MAR 01, 2011							
WDJVFF	1 ID CAB	AC	SourcingDecision	365	3/2/2032	3/1/2033	FY32
WDJVFF	1 ID CAB	AC	BOGMetric	365	3/2/2032	3/1/2033	FY32
WDJVFF	1 ID CAB	AC	DwellMetric	365	3/2/2033	3/1/2034	FY33
WDJVFF	1 ID CAB	AC	Available	365	3/2/2034	3/1/2035	FY34
WDJVFF	1 ID CAB	AC	DwellMetric	365	3/2/2035	2/29/2036	FY35
WDJVFF	1 ID CAB	AC	Available	365	3/1/2036	2/28/2037	FY36
WDJVFF	1 ID CAB	AC	DwellMetric	365	3/1/2037	2/28/2038	FY37
WDJVFF	1 ID CAB	AC	Available	365	3/1/2038	2/28/2039	FY38
WDQWAA	0101 HR COMPANY RECAP	AC	DwellMetric	365	3/16/2012	3/15/2013	FY12
WDQWAA	0101 HR COMPANY RECAP	AC	SourcingDecision	365	3/16/2013	3/15/2014	FY13
WDQWAA	0101 HR COMPANY RECAP	AC	BOGMetric	365	3/16/2013	3/15/2014	FY13
WDQWAA	0101 HR COMPANY RECAP	AC	DwellMetric	652	3/16/2014	12/27/2015	FY14
WDQWAA	0101 HR COMPANY RECAP	AC	SourcingDecision	365	12/28/2015	12/26/2016	FY16

Figure 5: FORSCOM's ARFORGEN Synchronization Tool

While MAJ Dabkowski and MAJ Zais noted in their 2009 Technical Report that the AST had "several shortcomings [that] prevented it from serving as a plug-and-play input" (Dabkowski et al., 2009), we set out to eliminate these shortcomings. With programming assistance from ProModel ©, we were able to code the model so that we can now cut and paste the schedule from FORSCOM AST output directly into our model without any reformatting required. A macro 'Create Schedule' button generates the following example input formatted for simulation (Figure 6):

Enter Model Start	Run Yrs	Schedule Name (optional):			12 DWELL - 12 BOG							
10/01/2014	20	MODEL INPUT (AST SCHEDULE)										
UIC	Unit Index	Unit Type	Geo Loc	Event Type	MRE-45	MRE(LAD-90)	LAD	R	R+90	R+180	Starting Bin	Starting Priority
WEPQFF	141	Heavy	CONUS	BOG	20130219	20130405	20130704	20140704	20141002	20141231	4	1
WDY6AA	134	HR_CO_RECAP	CONUS	BOG	20130307	20130421	20130720	20140720	20141018	20150116	4	1
WHLUAA	181	PUB_AFF_DET	CONUS	BOG	20130313	20130427	20130726	20140726	20141024	20150122	4	1
WAXZAA	55	HHB_ADA_BDE	OCONUS	BOG	20130327	20130511	20130809	20140809	20141107	20150205	4	1
WNG3AA	210	ACQ_CONTR_BN	CONUS	BOG	20130327	20130511	20130809	20140809	20141107	20150205	4	1
WAPBFF	39	HQCONUS	OCONUS	BOG	20130327	20130511	20130809	20140809	20141107	20150205	4	1
WEPSFF	142	Heavy	CONUS	BOG	20130327	20130511	20130809	20140809	20141107	20150205	4	1
WJKCFF	192	IBCT	CONUS	BOG	20130327	20130511	20130809	20140809	20141107	20150205	4	1
WH4KFF	175	HBCT	CONUS	BOG	20130420	20130604	20130902	20140902	20141201	20150301	4	1
WAUKFF	50	CORPS_HQ	CONUS	BOG	20130421	20130605	20130903	20140903	20141202	20150302	4	1
WAR4FF	44	HBCT	CONUS	BOG	20130427	20130611	20130909	20140909	20141208	20150308	4	1
WND2FF	202	HHC_MI_BDE	CONUS	BOG	20130429	20130613	20130911	20140911	20141210	20150310	4	1
WJLDFF	193	IBCT	CONUS	BOG	20130501	20130615	20130913	20140913	20141212	20150312	4	1
WJTHFF	196	HBCT	OCONUS	BOG	20130527	20130711	20131009	20141009	20150107	20150407	3	1
WFT1AA	153	HHC_EXPED_SIGN_BN	CONUS	BOG	20130601	20130716	20131014	20141014	20150112	20150412	3	1
WGR7AA	166	FIN_MGMT_CTR	OCONUS	BOG	20130607	20130722	20131020	20141020	20150118	20150418	3	1
WC93AA	115	PUB_AFF_DET	CONUS	BOG	20130614	20130729	20131027	20141027	20150125	20150425	3	1
WB61AA	72	EOD_CO	CONUS	BOG	20130614	20130729	20131027	20141027	20150125	20150425	3	1
WH17AA	172	ADA_BATTERY	CONUS	BOG	20130615	20130730	20131028	20141028	20150126	20150426	3	1
WA8PAA	10	CHEM_BN	CONUS	BOG	20130615	20130730	20131028	20141028	20150126	20150426	3	1
WFP6FF	150	HHC_MP_BDE	CONUS	BOG	20130615	20130730	20131028	20141028	20150126	20150426	3	1
WA0UFF	5	FIRES_BDE	CONUS	BOG	20130621	20130805	20131103	20141103	20150201	20150502	3	1
WJLMFF	194	IBCT	CONUS	BOG	20130622	20130806	20131104	20141104	20150202	20150503	3	1
WAL1FF	30	SBCT	OCONUS	BOG	20130706	20130820	20131118	20141118	20150216	20150517	3	1
WJD5FF	186	Medium	CONUS	BOG	20130713	20130827	20131125	20141125	20150223	20150524	3	1
WJTVFF	197	IBCT	CONUS	BOG	20130714	20130828	20131126	20141126	20150224	20150525	3	1
WGZPAA	168	HHC_EXPED_SIGN_BN	CONUS	BOG	20130805	20130919	20131218	20141218	20150318	20150616	3	1
WJUTFF	198	HBCT	OCONUS	BOG	20130805	20130919	20131218	20141218	20150318	20150616	3	1
WHDLFF	179	HHC_ENG_BDE	OCONUS	BOG	20130809	20130923	20131222	20141222	20150322	20150620	3	1
WNG2X4	209	SPACE_DET	CONUS	BOG	20130810	20130924	20131223	20141223	20150323	20150621	3	1

Figure 6: Depiction of the AST Schedule in a readable format

One example of a recent steady-state rotation scenario has the following parameters:

- Start Date: October 1, 2014
- End Date: September 30, 2034
- Deployment Length: 365 days
- RIP-TOA Overlap: 25 days
- MRE Date: LAD-90
- Active Component Demand: 1 Corps/3 Divisions/15 BCTs/41K Enablers

Table 4: Shows the AC demand breakdown of the 15 BCTs and 41,000 Enablers in our scenario.

Units	Demand Per Year
Acquisition Contracting BN	2
ADA Battalion (Patriot/MEADS)	1
ADA Battery (THAAD)	1
Chemical BDE	1
Chemical BN	1
Combat AVN BDE (CAB)	4
CORPS HQ	1
Division HQ	3
EOD BN	3
Financial Management CTR	1
HHB ADA BDE (EAC)	1
HHB FIRES BDE	3
HHC EN BDE	2

Units	Demand Per Year
HHC Expeditionary Signal BN	4
HHC Medical Brigade	1
HHC MI BDE (MIB	1
HHC MP BDE	1
HR CO RECAP	2
Human Resources Sustainment Center	1
HBCT	6
IBCT	8
MAMD BN (Avenger/SLAMRAAM)	1
Public Affairs DET	7
Space Detachment	1
SBCT	1

5.2 Controls

Represented by the arrows entering the top side of the IDEF0 diagram in Figure 3, the controls in this model govern how Soldiers mature (separation, reenlistment, promotion, and assignment), how units are manned, and human resource policies that may affect the degree to which the Army can stress the force. A brief summary of these policies and regulations is given below (Dabkowski et al., 2009).

ALARACT 253/2007 IDT Deployment Policy: This policy defines and specifies the regulations pertaining to individual dwell time (IDT). IDT is primarily defined as "the time a Soldier spends at home station after returning from combat deployment." IDT "is accrued at the rate of one month dwell per month deployed." Also, IDT "for combat deployments of 12 months or longer is at least 12 months." This also means that if a deployment is longer than 12 months, a Soldier is only guaranteed 12 months of dwell. Additionally, "Soldiers may be reassigned, to include a permanent change of station (PCS), during the individual dwell period. However, the Soldier's earned dwell time carries over to the gaining command." Finally, "for critical operational requirements, the first General Officer (GO) in the chain of command can approve a voluntary or involuntary written waiver of earned IDT and direct a Soldier's deployment" (Department of the Army, 2007), but we decided to keep the model simple and not allow Soldiers to deploy until they got their 12 months of earned IDT.

12 Month BOG Policy: This policy specifies that "[s]tarting 1 August 2008, AC Army units and Soldiers deploying to a named operation will deploy for not more than 12 months BOG" (Department of the Army, 2008a). Therefore, we ensured that the AST only depicted 12 month rotations.

AR 635-200 Enlisted Separations: Soldiers may be separated from the Army for a variety of unforeseen administrative or punitive reasons. Instead of modeling each separation as a unique decision tree, we decided to simplify the model (which led to increased speed) by using historical loss rate data. For each MOS and grade, the Army G1 provided us with historical loss rates from Nov 2004 to May 2010. Each month, our model would sample randomly from this data to assess the losses by grade and MOS. Please see Table 5 for a sample of the loss rates for the 35 Series.

Table 5: Shows a sample of the historical loss rates by grade (35 Series).

Average	Data Rows	Data Rows	Data Rows	Data Rows	Data Rows	Data Rows
0.0229	66	60	54	56	58	45
DATE	E3-E4	E5	E6	E7	E8	E9
200907	0.0101	0.0192	0.0089	0.0155	0.0189	0.0224
200908	0.0092	0.0179	0.0120	0.0149	0.0178	0.0078
200909	0.0100	0.0198	0.0123	0.0074	0.0206	0.0074
200910	0.0092	0.0167	0.0095	0.0101	0.0073	0.0155
200911	0.0104	0.0184	0.0114	0.0112	0.0103	0.0080
200912	0.0082	0.0070	0.0065	0.0065	0.0088	0.0169
201001	0.0083	0.0263	0.0106	0.0049	0.0088	0.0508
201002	0.0096	0.0186	0.0079	0.0049	0.0089	0.0089
201003	0.0134	0.0204	0.0114	0.0120	0.0135	0.0117
201004	0.0106	0.0165	0.0114	0.0116	0.0091	0.0119
201005	0.0094	0.0177	0.0089	0.0068	0.0168	0.0060

By using historical rates to model attrition in the model, we were able to focus our modeling effort on the factors most relevant to the Soldiers' BOG:Dwell ratio.

AR 601-280 Army Retention: In general, if a Soldier serves in the Army beyond his initial term of enlistment, then the Soldier has reenlisted. There are a number of key policies that are found in AR 601-280.

- A Soldier is eligible for reenlistment no earlier than 24 months and no later than 3 months prior to his/her Expiration Term of Service (ETS) (Department of the Army, 2006).
- If (1) a Soldier will have greater than 10 years of Active Federal Service (AFS) by the end of his current ETS and (2) he/she is an E6 or higher, then he/she must reenlist indefinitely (Department of the Army, 2006).
- If a Soldier is not subject to the indefinite reenlistment described above, then he/she can elect to reenlist for 2, 3, 4, 5, or 6 years. However, a Soldier must select a contract length where (a) their new ETS is greater than their old ETS and (b) their new ETS minus their Basic Active Service Date (BASD) is greater than their Retention Control Point (RCP) as given in Table 6 (Department of the Army, 2006).

Table 6: Shows Retention Control Points for E3s-E9s.

Grade	RCP (months)
E3	120
E4	120
E5	180
E6	264
E7	288
E8	312
E9	360

We again used historical data to govern whether Soldiers in our model would initially enlist for 2, 3, 4, 5, or 6 years. Because initial contract lengths are highly dependent on CMF, it is important to disaggregate the historical distributions by CMF for sampling. For the 35 Series (Table 7), you can see that most Soldiers (50%) initially enlisted for 3 years.

Table 7: Historical data for initial enlistment contract lengths (35 Series).

RAW DATA (by year contract)					
Series	2 yr	3 yr	4 yr	5 yr	6 yr
35	0.3%	50.0%	24.1%	15.8%	9.8%

After looking at the past two years of reenlistment data and separating the term of service lengths by MOS and grade, analysts within the office of the Army G1 believe that there is not enough evidence to suggest that we need to provide separate empirical distributions for each MOS and/or grade for reenlistment (which is different than initial contract lengths).

Therefore, we made the decision to use the following distribution (see Table 8), which was provided by the Army G1, to govern reenlistments. This empirical distribution is reassessed periodically with the accumulation of historical data and new reenlistment policies.

Table 8: Shows the distribution of the reenlistment contract lengths.

Term Yrs 2	Term Yrs 3	Term Yrs 4	Term Yrs 5	Term Yrs 6
1%	46%	38%	8%	7%

If an entity (Soldier) makes it through the month-to-month loss probabilities (described above) all the way to his/her ETS, then he/she automatically reenlists based on these percentages in Table 8.

AR 600-8-19 Enlisted Promotions: We had to realistically mature the force over the 20-year simulation run. Therefore, it is critical to simulate the promotion of Soldiers. We used Table 9, which specifies the minimum Time in Service, Time in Grade, and Service Remaining Requirement (which is the time left until the Soldier's currently scheduled separation date), to govern the promotions (Department of the Army, 2008b).

Table 9: Shows the promotion requirements for E3s-E9s.

Grade	Min TIS Requirement (months)	Min TIG Requirement (months)	SRR Requirement (months)
E3	12	4	0
E4	24	6	0
E5	36	8	12
E6	72	10	12
E7	72	0	24
E8	96	0	24
E9	120	0	24

Additionally, the simulation promotes to requirements. Therefore, even if a Soldier is eligible for promotion, they are not promoted until there is a vacant requirement at a higher grade within the Army. In other words, they do not get promoted until there is a "space" available for them to occupy. Another way to look at this is that the Army does not promote enlisted Soldiers unless promotions are necessary to fill requirements. Within the simulation, the following sequence of events is an example of what might happen. An E9 leaves the Army due to retirement (loss probability). There now exists a requirement to promote an E8 to E9. Once an E8 is promoted to E9, then that E8 slot is available for a promotion eligible E7. Once that E7 takes that E8 slot, then the E7 slot is open for a promotion eligible E6. This continues until an E5 gets promoted to E6. Once that happens, a promotable E4 takes the empty E5 slot, and then the simulation creates a new E3. Moreover, this is how we keep our Army at its desired size throughout the promotion process. A diagram of promotion logic using Microsoft Visio is depicted in Figure 7.

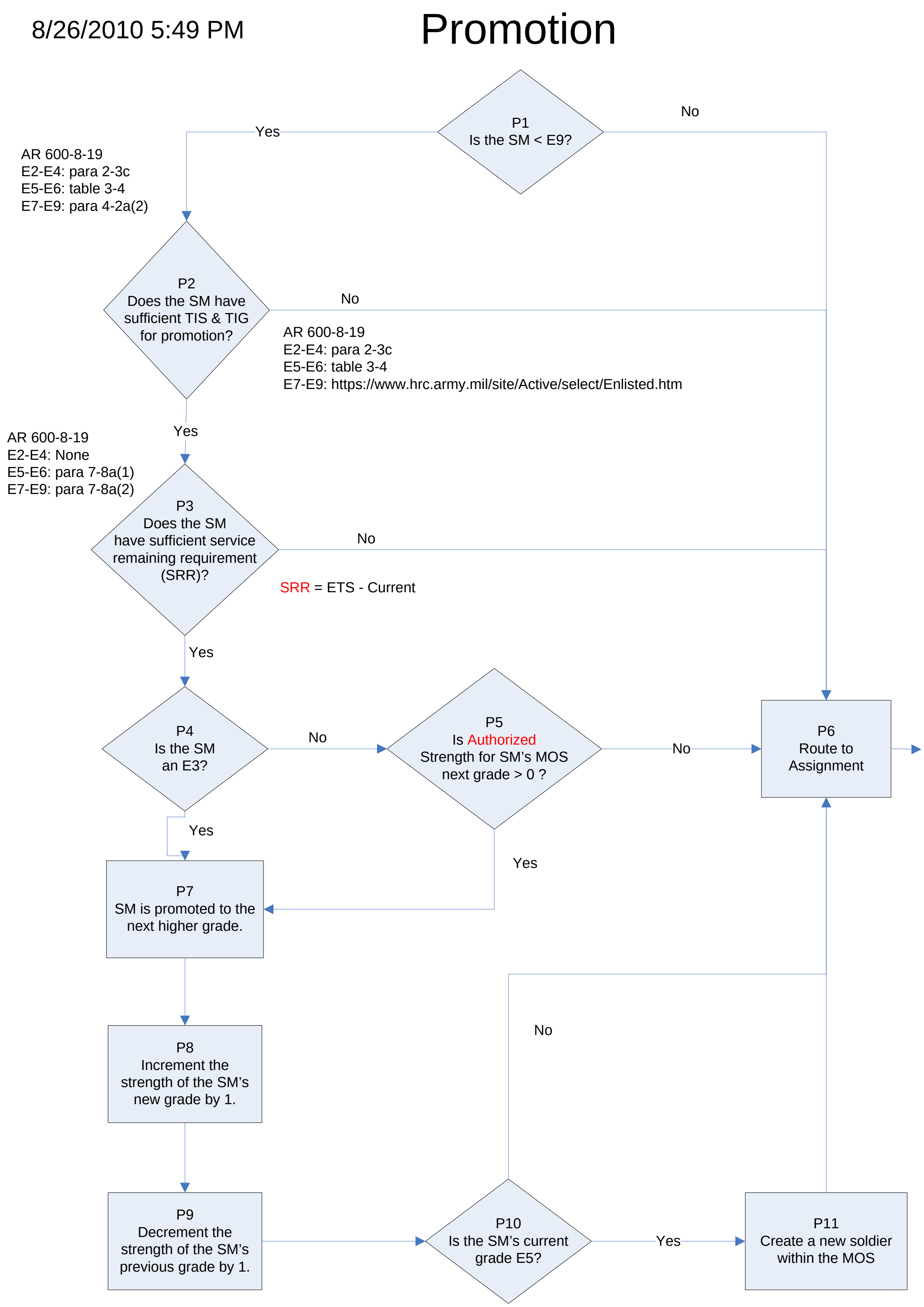


Figure 7: Promotion logic that we used to determine whether a soldier was promoted

DODI 1315.18p – Procedures for Military Personnel Assignments: This document "[u]pdates DoD procedures, and responsibilities pertaining to the assignment and reassignment of service members, [and] [e]stablishes uniform procedures for filling military billets." (Department of Defense, 2005). There are numerous assignment rules found in this DoD policy, including exceptions to these rules. With the mindset that we want to keep our model as simple as possible, we adhered to the following:

- Time on Station (TOS) Requirements: "The minimum TOS requirement for all assignments within or from the CONUS shall be for 36 months" (Department of Defense, 2005). The only exception we made was for Korea, where we specified a 12 month TOS.

- Retainability Requirements:

  - CONUS-to-CONUS moves: "2 years retainability after arrival at the gaining installation" (Department of Defense, 2005). However, we simplified our model by relaxing this constraint and said that all moves are possible as long as the Soldier's ETS is greater than 24 months away.
  - CONUS-to-OCONUS and OCONUS-to-OCONUS moves: "Service members shall not depart the CONUS or other departure ports unless they shall have obtained the retainability for serving the prescribed tour" (Department of Defense, 2005). Based on the TOS requirement above, this equates to 36 months. Nevertheless, based on our simplification described above, we allowed overseas moves as long as the Soldier's ETS was greater than 24 months away.
  - Korea-to-CONUS and OCONUS-to-CONUS: "a minimum of 12 months retainability" (Department of Defense, 2005). If a Soldier has between 12-24 months of retainability, he/she could either PCS back to CONUS (as long as their remaining TOS was 2 months or less.) or remain at that duty station.

- First Term Soldiers: In general, the number of tours an initial term Soldier serves should be limited.

Please see the assignment logic in Figure 8.

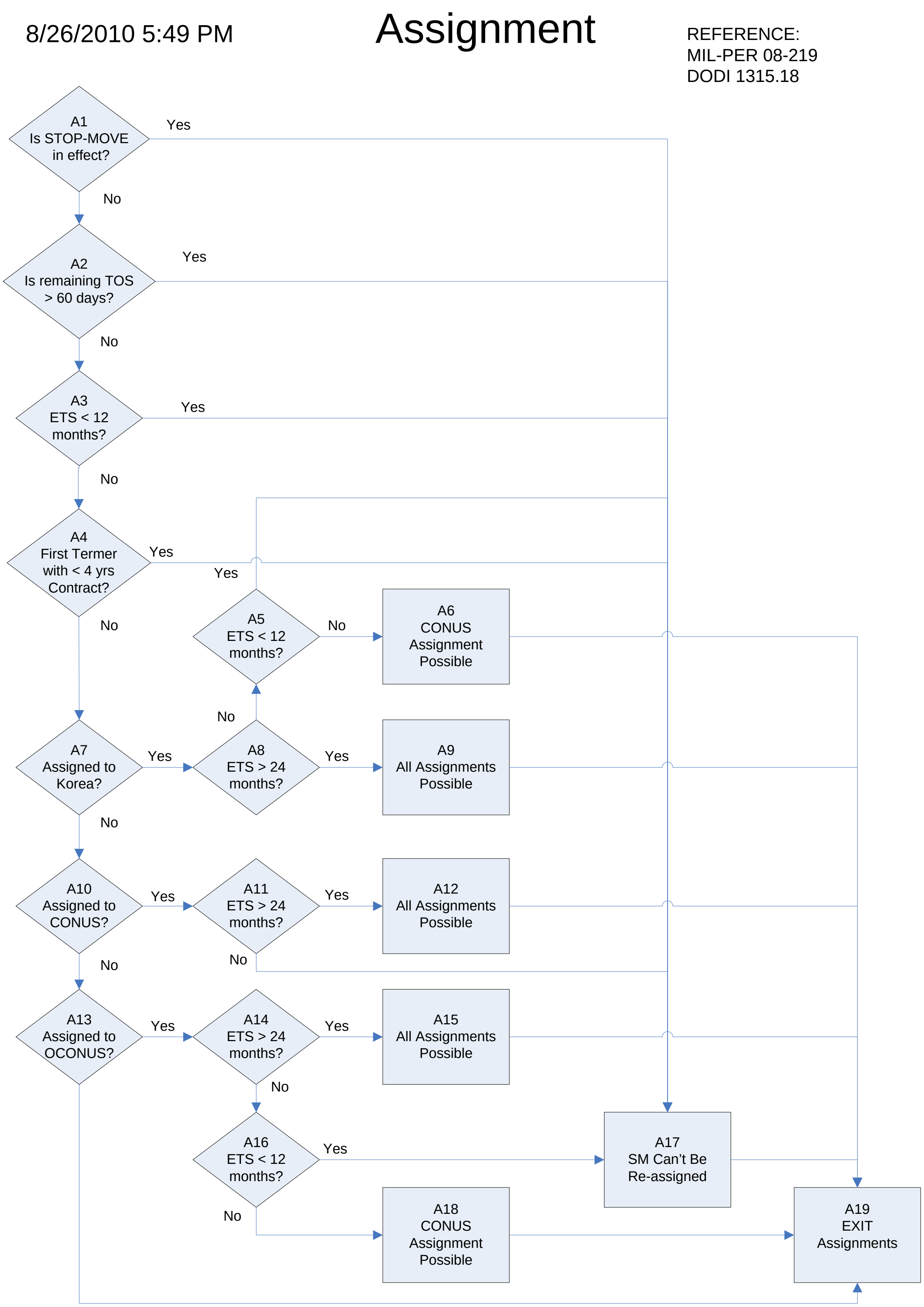


Figure 8: Assignment logic that we used to determine whether a soldier was available to PCS

ARFORGEN Focused Manning (AFM): AFM directs that the "Army will man and prioritize units based on deployment (LAD), major training exercises (MRE), and redeployment (R) dates" (Department of the Army, 2008d). Additionally, it ties these dates to specific manning goals via the HQDA AC Manning Guidance (Department of the Army, 2008c). From the AFM policy, these manning goals, and conversations with the Army G1 over the past year, we were able to assign fill priorities based on these dates. For example, as a unit is gearing up to deploy at LAD-90, we would fill that unit to 'Fill Priority 1', or 105%, and keep that unit at 'Fill Priority 1' until R+90. At that point, we would drop that units fill priority to a 6, or 80%, until R+180. Then, it would change to a 4 (90% target fill) until MRE-45 where the "plus-ing up" of the unit would continue as the fill priority moves to a 2 (100% target fill). Please see Figures 9 and 10. In Figure 10, you can see how the actual fill percentages (represented by the blue lines) are attempting to keep up with the target fill percentages. You can see that, in the BCTs, it is hard for them to shed off their excess Soldiers once the unit hits 'Fill Priority 6' (80% target fill). On the other hand, they very quickly get the Soldiers they need once their fill priority goes back towards 'Fill Priority 1' (105%). What is great about this is that it is scalable. We can change the target fill percentages to whatever number we want and re-run the model. This is a great example of how our model can be helpful to decision makers who want to see how a change in policy affects the BOG:Dwell ratio as well as whether that change in policy has beneficial and/or feasible results.

Bin	FILL PRIORITIES AND TARGET PERCENTAGES								
Number	1	2	3	4	5	6	7	8	9
	BCTs / CAB / HQ (Time dependent relative to deployment date)						OTHER	TDA	KOREA
Description	MRE-45 to LAD-90	LAD-90 to LAD	LAD to R	R to R+90	R+90 to R+180	R+180 to MRE-45	Constant	Constant	Constant
Fill Priority	2	1	1	1	6	4	4	5	3

Fill Priority	Fill Target	100% Scenario
1	105%	100%
2	100%	100%
3	95%	100%
4	90%	100%
5	85%	100%
6	80%	100%
7	0%	0%
8	0%	0%
9	0%	0%

Figure 9: Fill priorities and target fill percentages used in our model

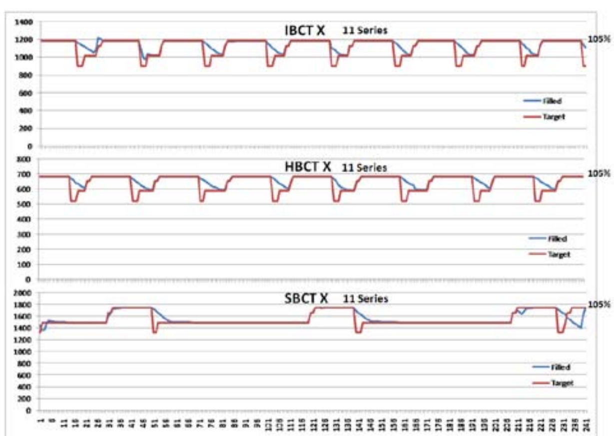


Figure 10: Graph over time of the target fill percentages vs. actual fill percentages for a unique IBCT, HBCT, and SBCT (11 Series)

5.3 Mechanism

In order to accept the input, implement controls, and generate output, we decided to use discrete event simulation, a technique which "accounts for interdependencies and variation…provid[ing] insights into the complex dynamics of a system that cannot be obtained using other analysis techniques" (Harrell et al., 2004).

With this in mind, we elected to use the discrete event simulation software package ProModel ©. It is worth pointing out that Promodel is used in FORSCOM's AST model and that helps to facilitate interoperability (Dabkowski et al., 2009).

Other Army organizations that use ProModel include: Center for Army Analysis (CAA), U.S. Army Accessions Command, Plans and Resources Directorate of the Army G1 (PRS), West Point's Department of Systems Engineering, and West Point's Department of Mathematics.

5.4 Output

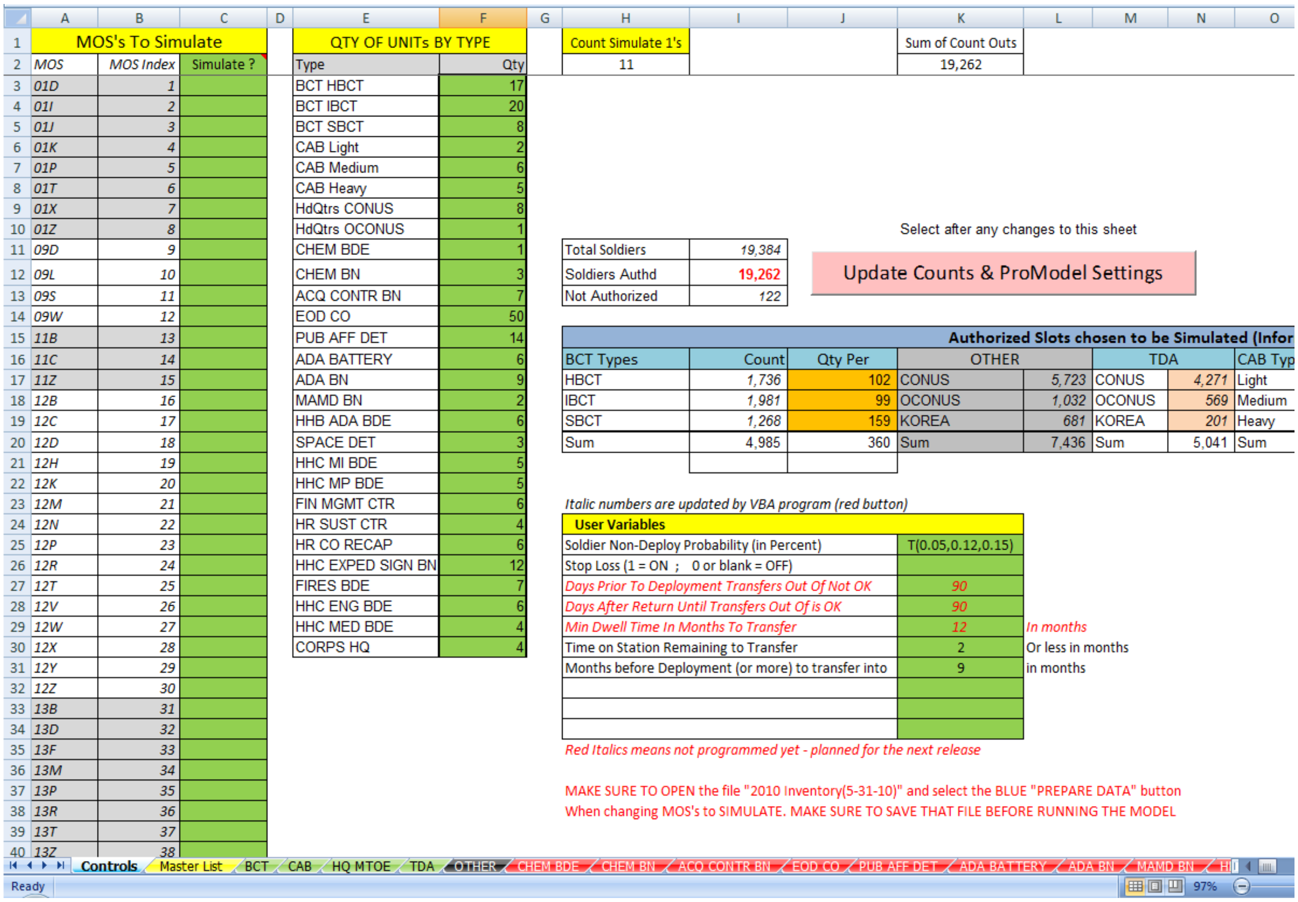
The BOG:Dwell ratio that our model produces is an aggregated measure that indicates the deployment stress on the Army's Soldiers. Since we want to be consistent with the Army's IDT policy, we want to capture the time a Soldier spends at home between deployments. With this in mind, after dividing each deploying Soldier's dwell by his/her BOG, we could take the mean of the sample, leaving us with a single, representative metric for the whole. However, if you are familiar with the "Flaw of Averages," you know that using the mean can severely misrepresent the pain that the average Soldier is experiencing. Outliers can greatly impact the average. So, we decided to retain the 2009 findings and recommendations of MAJ Dabkowski and MAJ Zais and report the median, or middle value, of the BOG:Dwell statistics (Dabkowski et al., 2009). Our model still computes averages so that we can compare the median and the average. Finally, we also decided to represent the individual dwell statistics as a histogram and box plot. Specifically, we were able to capture the distributions of individual BOG:Dwell ratios by CMF alone and by MOS and grade. This allowed us to report a rich set of statistics that fully described the deployment stress on the force.

6 SIMULATION STRUCTURE

MAJ Dabkowski and MAJ Zais's 2009 ProModel simulation was "nearly 5 megabytes in size, consist[ed] of 12 entity types, 47 arrays, 121 attributes, 280 variables, 295 macros, 1020 locations, 1300 processes, and 32 subroutines" (Dabkowski et al., 2009). This model was only for the 11 Series, and it took over 27 hours to run. One of our goals for 2011 model was to speed up the run time while adding the ability to analyze multiple, critical MOSs. With contracted programming support from ProModel, the simulation run time has been significantly reduced. The largest CMF (11 Series) can be simulated in less than 2 hours, which is 7% of the original run-time or a 1500% increase in speed.

In order to run this discrete event simulation, there are only three macro-enabled Excel input files that need to be open in addition to the ProModel file (titled 'BOG DWELL - NEW v58.MOD'). Those three Excel files are: (1) Data File Input - v9.xlsm, (2) Schedule File Input - v3.xlsm, and (3) 2010 Inventory (5-31-10).xlsm.

6.1 Data File Input - v9.xlsm



MOS's To Simulate

MOS	MOS Index	Simulate ?
01D	1	
01I	2	
01J	3	
01K	4	
01P	5	
01T	6	
01X	7	
01Z	8	
09D	9	
09L	10	
09S	11	
09W	12	
11B	13	
11C	14	
11Z	15	
12B	16	
12C	17	
12D	18	
12H	19	
12K	20	
12M	21	
12N	22	
12P	23	
12R	24	
12T	25	
12V	26	
12W	27	
12X	28	
12Y	29	
12Z	30	
13B	31	
13D	32	
13F	33	
13M	34	
13P	35	
13R	36	
13T	37	
13Z	38	

QTY OF UNITs BY TYPE

Type	Qty
BCT HBCT	17
BCT IBCT	20
BCT SBCT	8
CAB Light	2
CAB Medium	6
CAB Heavy	5
HdQtrs CONUS	8
HdQtrs OCONUS	1
CHEM BDE	1
CHEM BN	3
ACQ CONTR BN	7
EOD CO	50
PUB AFF DET	14
ADA BATTERY	6
ADA BN	9
MAMD BN	2
HHB ADA BDE	6
SPACE DET	3
HHC MI BDE	5
HHC MP BDE	5
FIN MGMT CTR	6
HR SUST CTR	4
HR CO RECAP	6
HHC EXPED SIGN BN	12
FIRES BDE	7
HHC ENG BDE	6
HHC MED BDE	4
CORPS HQ	4

Count Simulate 1's	Sum of Count Outs
11	19,262

Select after any changes to this sheet

Update Counts & ProModel Settings

Total Soldiers	19,384
Soldiers Authd	19,262
Not Authorized	122

Authorized Slots chosen to be Simulated (Infor

BCT Types	Count	Qty Per	OTHER		TDA		CAB Typ
HBCT	1,736	102	CONUS	5,723	CONUS	4,271	Light
IBCT	1,981	99	OCONUS	1,032	OCONUS	569	Medium
SBCT	1,268	159	KOREA	681	KOREA	201	Heavy
Sum	4,985	360	Sum	7,436	Sum	5,041	Sum

Italic numbers are updated by VBA program (red button)

User Variables		
Soldier Non-Deploy Probability (in Percent)	T(0.05,0.12,0.15)	
Stop Loss (1 = ON ; 0 or blank = OFF)		
Days Prior To Deployment Transfers Out Of Not OK	90	
Days After Return Until Transfers Out Of is OK	90	
Min Dwell Time In Months To Transfer	12	*In months*
Time on Station Remaining to Transfer	2	Or less in months
Months before Deployment (or more) to transfer into	9	in months

Red Italics means not programmed yet - planned for the next release

MAKE SURE TO OPEN the file "2010 Inventory(5-31-10)" and select the BLUE "PREPARE DATA" button
When changing MOS's to SIMULATE. MAKE SURE TO SAVE THAT FILE BEFORE RUNNING THE MODEL

Controls / Master List / BCT / CAB / HQ MTOE / TDA / OTHER / CHEM BDE / CHEM BN / ACQ CONTR BN / EOD CO / PUB AFF DET / ADA BATTERY / ADA BN / MAMD BN

Ready 97%

Figure 11: Screen shot of the 'Controls' tab in our 'Data File Input - v9.xlsm' file

Figure 11 is a screen shot of 'Data File Input - v9.xlsm.' The first thing that needs to be done after opening the file is to enable the macros. Then, select the MOSs that you want to simulate. The screen shot shown in Figure 11 is depicting that the 35 Series is going to be simulated, however you cannot see that cells C97 – C107 are selected for simulation. In cell H2, you can see that eleven 1's are counted. Once you have selected the MOSs you want to simulate, double check your user variables found in cells K25- K31 and the quantities of units by type in cells F3-F30, and then single click the 'Update Counts & ProModel Settings' button. Once the macro is finished running, save the file.

Across the bottom of this screen shot, you will find 30 more tabs (Master List, BCT, CAB, HQ MTOE, TDA, OTHER, Structure for 20 Enabler Units, Inventory Forecast 2014, Promotion Eligibility, Initial Contracts, and Reenlistment Contracts). If any changes to the model are needed or data needs to be updated, this is most likely where those changes/updates need to take place.

6.2 Schedule File Input - v3.xlsm

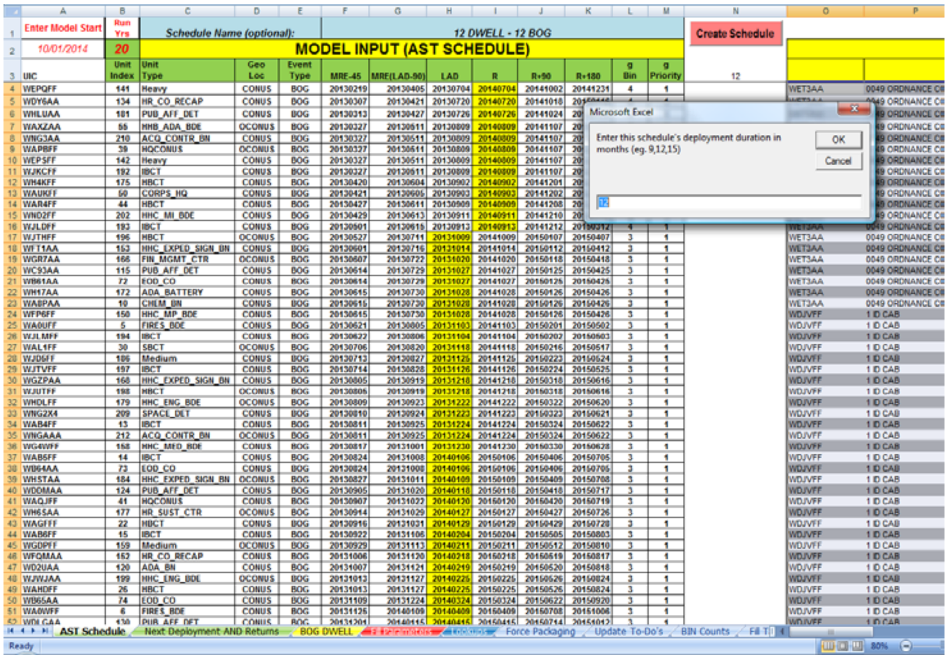


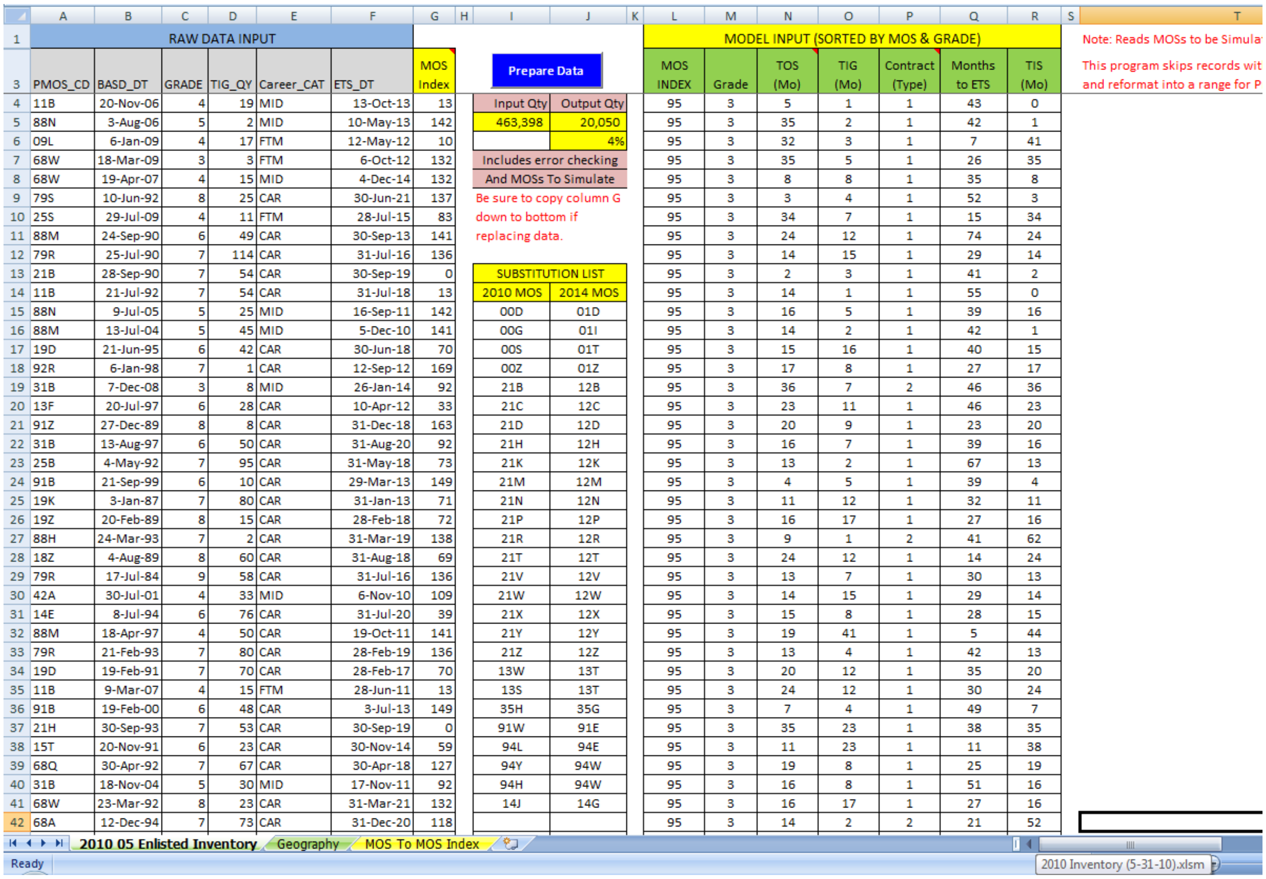
Figure 12: Screen shot of the 'AST Schedule' tab in our 'Schedule File Input – v3.xlsm' file

Figure 12 is a screen shot of 'Schedule File Input - v3.xlsm.' Again, the first thing that needs to be done after opening the file is to enable the macros. Next, in cell B2, select the number of years you want to simulate. Now, single click the 'Create Schedule' button and the dialogue box (shown above) will appear. Enter 12 and click OK. Once the macro is finished running, save the file.

Across the bottom of this screen shot, you will find 9 more tabs, but the only important one is the 'Fill Parameters' tab. When you click on that red tab, you see the screen shot that is depicted in Figure 13. We can change the fill target percentages to whatever number we want, save the file, and re-run the model.

Figure 13: Screen shot of the 'Fill Parameters' tab in our 'Schedule File Input – v3.xlsm' file

6.3 2010 Inventory (5-31-10).xlsm



	A	B	C	D	E	F	G	I	J	L	M	N	O	P	Q	R	T
1	RAW DATA INPUT									MODEL INPUT (SORTED BY MOS & GRADE)							Note: Reads MOSs to be Simula
3	PMOS_CD	BASD_DT	GRADE	TIG_QY	Career_CAT	ETS_DT	MOS Index	Prepare Data		MOS INDEX	Grade	TOS (Mo)	TIG (Mo)	Contract (Type)	Months to ETS	TIS (Mo)	This program skips records wit and reformat into a range for P
4	11B	20-Nov-06	4	19	MID	13-Oct-13	13	Input Qty	Output Qty	95	3	5	1	1	43	0	
5	88N	3-Aug-06	5	2	MID	10-May-13	142	463,398	20,050	95	3	35	2	1	42	1	
6	09L	6-Jan-09	4	17	FTM	12-May-12	10		4%	95	3	32	3	1	7	41	
7	68W	18-Mar-09	3	3	FTM	6-Oct-12	132	Includes error checking		95	3	35	5	1	26	35	
8	68W	19-Apr-07	4	15	MID	4-Dec-14	132	And MOSs To Simulate		95	3	8	8	1	35	8	
9	79S	10-Jun-92	8	25	CAR	30-Jun-21	137	Be sure to copy column G		95	3	3	4	1	52	3	
10	25S	29-Jul-09	4	11	FTM	28-Jul-15	83	down to bottom if		95	3	34	7	1	15	34	
11	88M	24-Sep-90	6	49	CAR	30-Sep-13	141	replacing data.		95	3	24	12	1	74	24	
12	79R	25-Jul-90	7	114	CAR	31-Jul-16	136			95	3	14	15	1	29	14	
13	21B	28-Sep-90	7	54	CAR	30-Sep-19	0	SUBSTITUTION LIST		95	3	2	3	1	41	2	
14	11B	21-Jul-92	7	54	CAR	31-Jul-18	13	2010 MOS	2014 MOS	95	3	14	1	1	55	0	
15	88N	9-Jul-05	5	25	MID	16-Sep-11	142	00D	01D	95	3	16	5	1	39	16	
16	88M	13-Jul-04	5	45	MID	5-Dec-10	141	00G	01I	95	3	14	2	1	42	1	
17	19D	21-Jun-95	6	42	CAR	30-Jun-18	70	00S	01T	95	3	15	16	1	40	15	
18	92R	6-Jan-98	7	1	CAR	12-Sep-12	169	00Z	01Z	95	3	17	8	1	27	17	
19	31B	7-Dec-08	3	8	MID	26-Jan-14	92	21B	12B	95	3	36	7	2	46	36	
20	13F	20-Jul-97	6	28	CAR	10-Apr-12	33	21C	12C	95	3	23	11	1	46	23	
21	91Z	27-Dec-89	8	8	CAR	31-Dec-18	163	21D	12D	95	3	20	9	1	23	20	
22	31B	13-Aug-97	6	50	CAR	31-Aug-20	92	21H	12H	95	3	16	7	1	39	16	
23	25B	4-May-92	7	95	CAR	31-May-18	73	21K	12K	95	3	13	2	1	67	13	
24	91B	21-Sep-99	6	10	CAR	29-Mar-13	149	21M	12M	95	3	4	5	1	39	4	
25	19K	3-Jan-87	7	80	CAR	31-Jan-13	71	21N	12N	95	3	11	12	1	32	11	
26	19Z	20-Feb-89	8	15	CAR	28-Feb-18	72	21P	12P	95	3	16	17	1	27	16	
27	88H	24-Mar-93	7	2	CAR	31-Mar-19	138	21R	12R	95	3	9	1	2	41	62	
28	18Z	4-Aug-89	8	60	CAR	31-Aug-18	69	21T	12T	95	3	24	12	1	14	24	
29	79R	17-Jul-84	9	58	CAR	31-Jul-16	136	21V	12V	95	3	13	7	1	30	13	
30	42A	30-Jul-01	4	33	MID	6-Nov-10	109	21W	12W	95	3	14	15	1	29	14	
31	14E	8-Jul-94	6	76	CAR	31-Jul-20	39	21X	12X	95	3	15	8	1	28	15	
32	88M	18-Apr-97	4	50	CAR	19-Oct-11	141	21Y	12Y	95	3	19	41	1	5	44	
33	79R	21-Feb-93	7	80	CAR	28-Feb-19	136	21Z	12Z	95	3	13	4	1	42	13	
34	19D	19-Feb-91	7	70	CAR	28-Feb-17	70	13W	13T	95	3	20	12	1	35	20	
35	11B	9-Mar-07	4	15	FTM	28-Jun-11	13	13S	13T	95	3	24	12	1	30	24	
36	91B	19-Feb-00	6	48	CAR	3-Jul-13	149	35H	35G	95	3	7	4	1	49	7	
37	21H	30-Sep-93	7	53	CAR	30-Sep-19	0	91W	91E	95	3	35	23	1	38	35	
38	15T	20-Nov-91	6	23	CAR	30-Nov-14	59	94L	94E	95	3	11	23	1	11	38	
39	68Q	30-Apr-92	7	67	CAR	30-Apr-18	127	94Y	94W	95	3	19	8	1	25	19	
40	31B	18-Nov-04	5	30	MID	17-Nov-11	92	94H	94W	95	3	16	8	1	51	16	
41	68W	23-Mar-92	8	23	CAR	31-Mar-21	132	14J	14G	95	3	16	17	1	27	16	
42	68A	12-Dec-94	7	73	CAR	31-Dec-20	118			95	3	14	2	2	21	52	

Figure 14: Screen shot of the '2010 05 Enlisted Inventory' tab in our '2010 Inventory (5-31-10).xlsm' file

Figure 14 is a screen shot of '2010 Inventory (5-31-10).xlsm.' Again, the first thing that needs to be done after opening the file is to enable the macros. Next, single click the 'Prepare Data' button. Once the macro is finished running, save the file.

In the center of this Excel sheet you will a 'Substitution List.' This is where MOS conversions are handled. For example, the 21 Series is converting to the 12 Series. Therefore, when we simulated the 12 Series, it is actually using 21 Series attributes (from the TAPDB) to create the 12 Series Soldiers. (Also, note that the 'Data File Input - v9.xlsm' file does not allow you to simulate the 21 Series.)

Across the bottom of this screen shot, you will find 2 more tabs (Geography & MOS to MOS Index), but they will not need updating.

6.4 BOG Dwell - New v58.mod

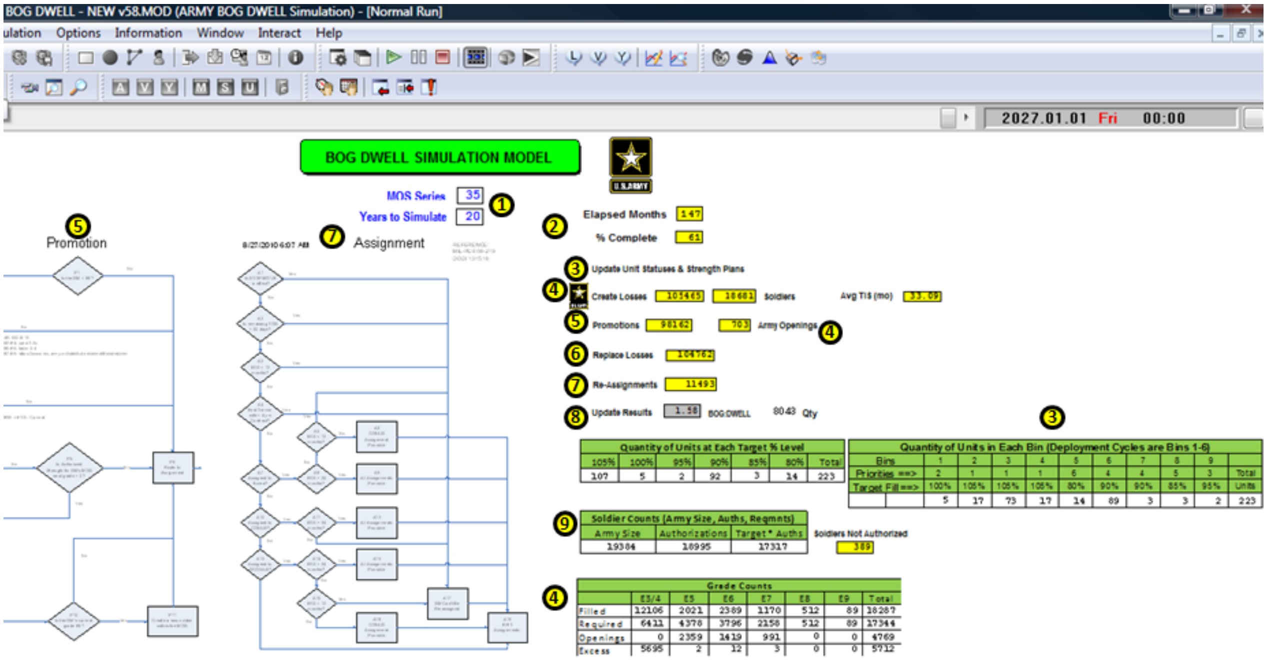


Figure 15: Screen shot of the animation page of our simulation that is built in ProModel

Now that the three Excel input files have been open, updated, and saved, we can now move to the ProModel interface. Figure 15 depicts a screen shot of the animation page. To walk through the simulation structure, we have numbers on the figure above and will discuss each number in order.

1. Depicts the MOS Series (or CMF) that you are simulating and the length of the simulation run (in years).
2. Continuously updates the months that have elapsed during the simulation run and lets the user know the percentage of the run that is complete.
3. The table to the far right shows how many units are in each fill priority bin. This is dynamically updated every month. The table right next to it gives the roll up of how many units are filled to 105%, 100%, 95%, 90%, 85%, and 80%.
4. Every month, Soldiers are "lost" from the simulation for a variety of unforeseen administrative or punitive reasons. Every loss creates an opening in the model. For example in the screen shot above, 703 losses occurred in month 147, bringing the total number of 35 Series Soldiers down from 19,384 to 18,681. A table at the bottom of the animation page serves as a checks and balances to see if each grade is getting what they require. It is easy to see that there are excess Soldiers in the Army in the grades of E3/E4, but there are numerous openings for E5, E6, and E7.
5. Now that there are openings, or spaces in the PMAD, that need to be filled, we first fill those openings by running each and every Soldier through the promotion logic. (See promotion logic in Figure 7.) If a Soldier was eligible for promotion, but could not move because

there was no opening for their next grade, then we did not promote them. Once there is an opening as a result of a loss (step 4), then we first look to promote within the same unit, then within the same geographic location, and then finally to other geographic locations (i.e. the Soldier is PCS'd given he/she meets the requirement for PCS). The bottom line is that we are promoting to requirements, which is how the Army G1 manages promotions.

6. Any openings that are not filled as a result of the promotion logic causes new E3s to be created to get the total number of 35 Series Soldiers back to 19,384. The number of Soldiers that are replaced (created) in month 147 are added to the cumulative 'Replace Losses' amount and are tracked on screen.
7. Next, every Soldier goes through the assignment logic (found in Figure 8). If the Soldier meets the criteria for reassignment and there is a hole in the Army at another location for them, then they will PCS. This will cause the 'Re-assignment' amount to increase on the animation screen. If the Soldier's remaining TOS is 2 months or less and there is no hole available in the Army, then they will not PCS and their remaining TOS will decrease by 1 month. However, their remaining TOS will never go below 1 month. As a result, that Soldier will attempt to PCS every month until a hole opens up. The only other way for the 'Re-assignments' counter to increase on screen is when a promotion occurs that moves a Soldier from one duty location to another.
8. Finally, our model is constantly updating the BOG:Dwell ratio. On screen, you can see that the average dwell for the 35 Series (at month 147) is 1.58 years after 8,043 data points have been recorded.
9. There is a table titled 'Soldier Counts (Army Size, Auths, Reqmnts)' that tracks Army Size versus Authorizations. The authorization number found on the ProModel animation page (18,995) is slightly different than the authorized number found in Table 2 (19,262), but that is a result of an Excel rounding error. So, the 389 Soldiers that are reported as excess is absolutely correct.

   Also, in the table titled 'Soldier Counts (Army Size, Auths, Reqmnts)' the 'Target*Auths' number of 17,317 is a number that changes by the month. As the ARFORGEN process cycles through time, the units that are filled to 105% are constantly changing. This 'Target*Auths' number ends up being the 'Required' number found in the 'Total' column of the 'Grade Counts' table.

7 CAPABILITIES

First and foremost, this model is scalable. Unlike the original version of this model, it is capable of modeling any MOS that is included in FORSCOM's AST. Currently, the model can run the BCT centric CMFs of 11, 13, and 19. Additionally, it can run the Combat Aviation Brigade (CAB) centric CMF, which is 15. Finally, it is able to model five critical enabler CMFs (12, 25, 31, 35, and 89) whose units are included in the AST schedule.

How else is this model significantly improved from the version released in 2009? The data input and update process has been significantly streamlined. First, instead of having decision logic in our model (for example, will the Soldier reenlist or not? Will the Soldier retire or not? Will the Soldier get in trouble and get separated or not?), we aggregated all the loss rates by

MOS. This significantly sped up our model. Second, we no longer have to reformat FORSCOM's AST. We can simply cut and paste it directly into our Excel input file called 'Schedule File Input - v3.xlsm.' Lastly, we got rid of nearly every entity and location within ProModel and instead ran sub-routines, which are so much faster. This streamlining of data greatly reduced our simulation run-times. The 11 Series (our largest CMF) used to take 27 hours to run. Now it only takes 1 hour and 45 minutes to run. Some smaller CMFs only take about 30-40 minutes to complete a run.

8 RESULTS

We ran a steady-state simulation for the following Career Management Fields (CMFs): 11 (Infantry), 12 (Engineers), 13 (Field Artillery), 15 (Aviation), 19 (Armor), 25 (Signal), 31 (Military Police), 35 (Military Intelligence), and 89 (Explosive Ordnance Disposal). You may recall that we previously defined the steady-state as a 20-year analysis period starting on October 1, 2014 where (a) the AC Demand scenario is 1 Corps, 3 Divisions, 15 BCTs, 41K Enablers (normally represented as: 1/3/15/41K), (b) the standard deployment length is 1 year, (c) the RIP-TOA overlap is 25 days, and (d) the Army's authorized end strength is 463,398 Soldiers. After running the simulation, we analyzed the output data using the statistical software program MiniTab.

The boxplot is a great way to visually convey statistical information. In particular, each boxplot's colored, rectangular region represents the middle 50% of the sample (or interquartile range); the horizontal line inside of the colored region is the median; and the line or whiskers emanating from its top and bottom represent the sample's upper and lower 25%. Any values which are greater than 1.5 times the interquartile range are considered outliers, and these unusual observations are plotted as asterisks. We removed these outliers from some of our figures to "clean" them up. With the explanations out of the way, we can now focus on interpreting the results.

Figure 16 compares dwell years by grade for the 11 (Infantry), 13 (Field Artillery), 15 (Aviation), and 19 (Armor) CMFs. Since all of the colored regions of the boxplots fall below the 2-year dwell line (shown in red), we can conclude that more than 75% of the Soldiers in these CMFs failed to experience a 1:2 BOG:Dwell ratio. In fact, only the 13 Series E7s and the E7s and E8s in the 19 Series have a significant portion of Soldiers getting 2 years of dwell (their upper whisker crosses over the 2-year dwell line). The lower enlisted Soldiers in the BCTs and CABs are not faring well at all. Specifically, in the BCTs, the dwell year medians for the skill level 1 (SL1) Soldiers (which equates to the E3s and E4s in our model) are all below the E6s, E7s, and E8s.

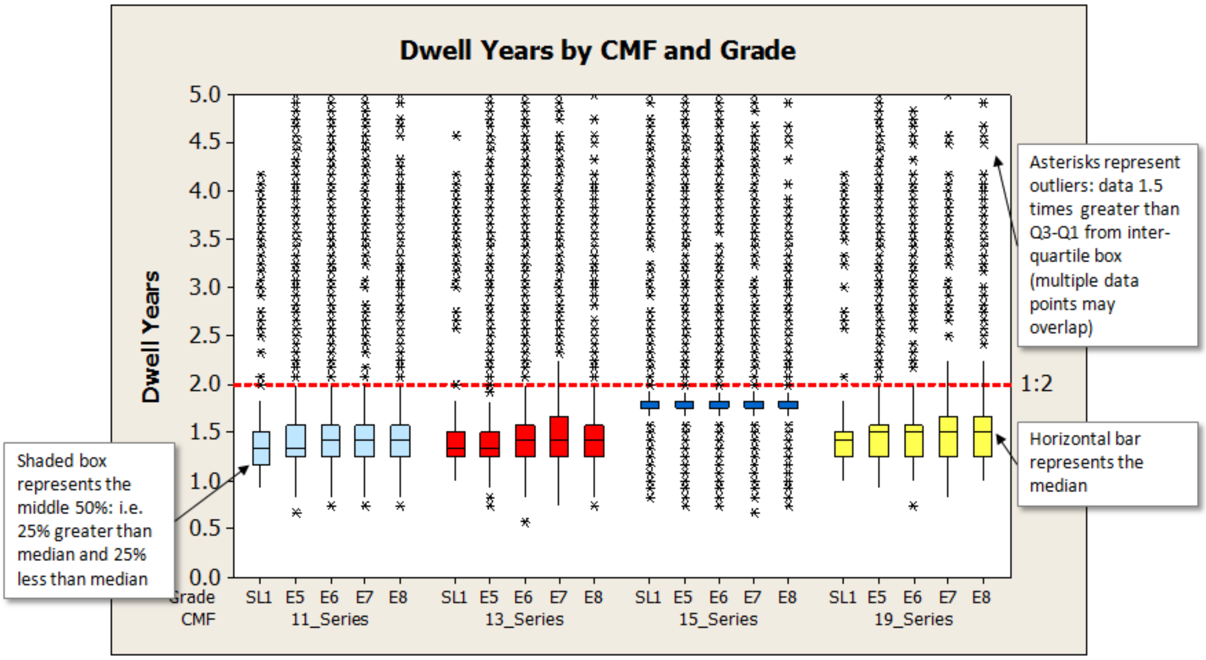


Figure 16: Dwell Year by CMF and Grade (11, 13, 15, and 19 Series)

Next, we compared the 12 (Engineers), 25 (Signal), 31 (Military Police), 35 (Military Intelligence), and 89 (Explosive Ordnance Disposal) Series. See Figure 17. These are five of the most critical enablers CMFs that the Army G1 wanted us to analyze. It is again clear to see that most Soldiers are not getting 2 years of dwell time. In fact, in each of these CMFs, the median for each grade falls below the red line. Also, only the E8s in the 31 and 35 Series have portions of their boxplot well over the 2-year dwell line. Additionally, the SL1s have lowest median dwell times in the 12, 25, 31, and 35 Series. Interestingly, the 89 Series SL1 has the highest median dwell time in its series. However, none of its upper whisker crosses the red line. So essentially, almost every SL1 in the 89 Series is failing to get 2 years of dwell time.

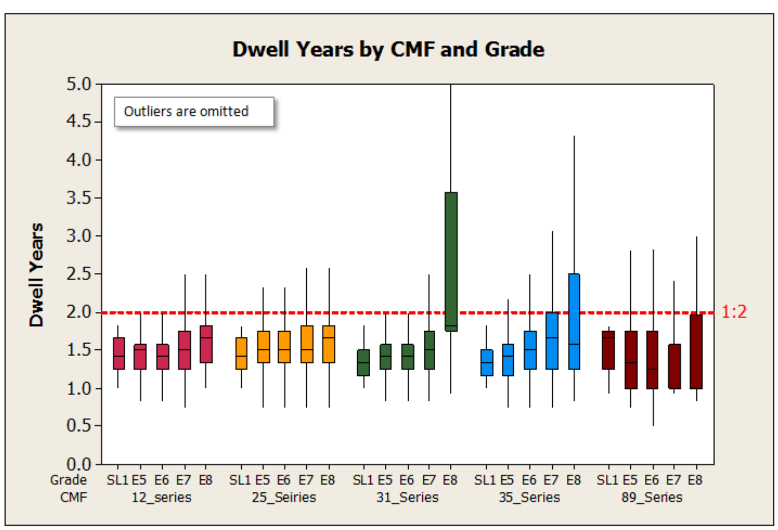


Figure 17: Dwell Year by CMF and Grade (12, 25, 31, and 89 Series)

We then wanted to plot the median dwell times for each MOS. Please see Figure 18. It is clear to see that only three MOSs (15K, 31D, and 12P) achieve the Army's BOG:Dwell ratio goal of 1:2. 25E and 35X were the next closest MOSs to achieving the Army's goal. The MOSs that fared the worst are 12C, 35Y, and 89D.

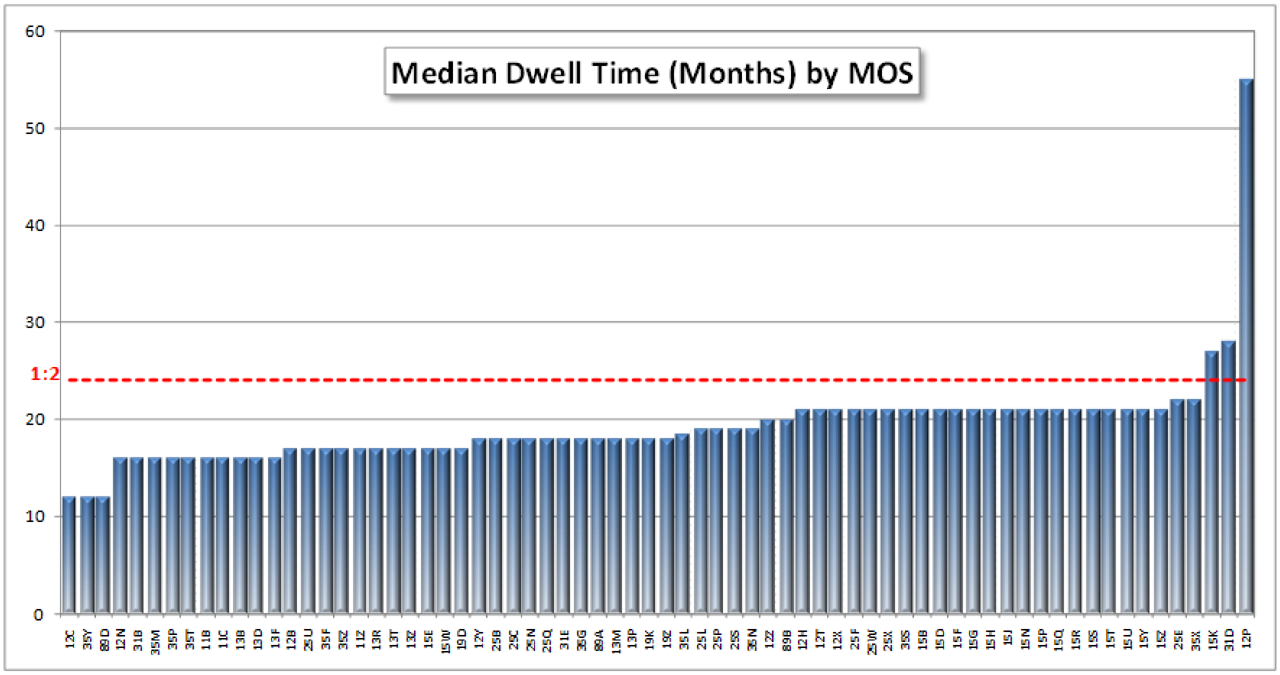


Figure 18: Median Dwell Time (in months) by MOS (11, 12, 13, 15, 19, 25, 31, 35, and 89 Series)

Next, we graphed the median dwell times for grade and MOS (Figure 19). (You will not see E3s because by the time they have a dwell statistic, they have been in the Army long enough to make E4. We also excluded E9s to save space.) Only 15K E7s, 31D E7s, 25P E7s, 35L E6s, 31E E8s, and 12P E6s achieve a median dwell greater than two years. 12C E4s/E5s/E6s, 13M E7s, 13T E7s, 25F E4s/E5s, 31E E4s/E5s, 89D E4s/E5s/E6s/E7s/E8s, and 35Y E8s all tied for the worst median dwell time of 12 months. This makes it clear to see why 12C and 89D as a whole fared so poorly.

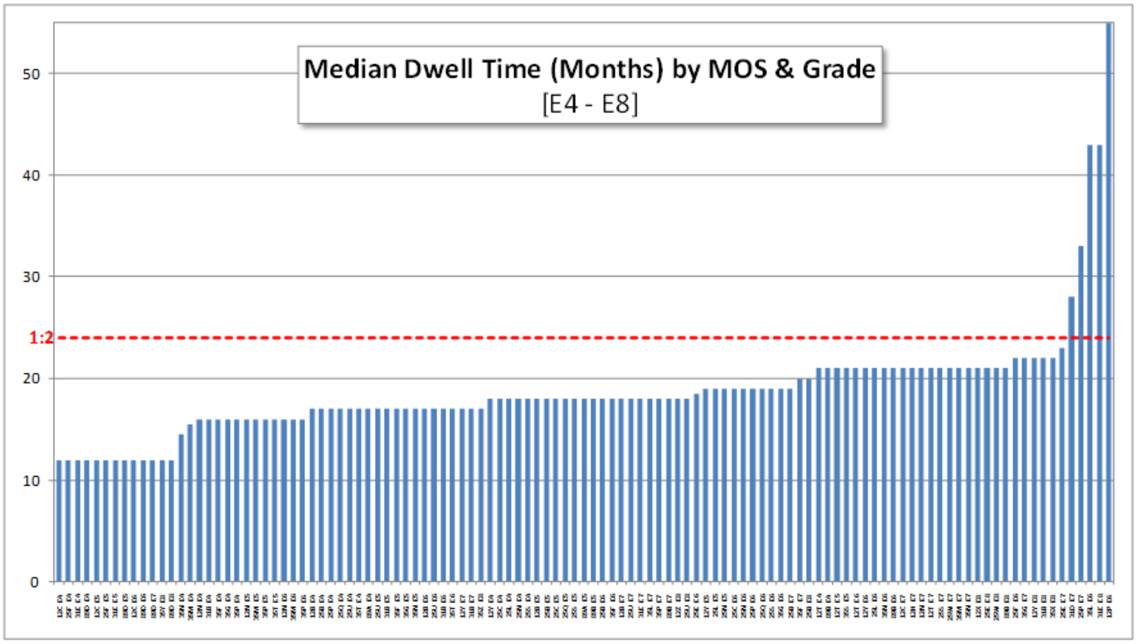


Figure 19: Median Dwell Time (months) by MOS (11, 12, 13, 15, 19, 25, 31, 35, and 89 Series) & Grade

Please see Appendix A (Figures 21-29) for more detailed results. The figures in Appendix A display the dwell years by MOS and grade for the nine CMFs (11, 13, 15, 19, 12, 25, 31, 35, and 89) we analyzed.

9 VERIFICATION AND VALIDATION

As the famous statistician George Box rightly stated, "All models are wrong, some are useful" (Parnell et al., 2011). As such verification and validation are the methods by which we try to ensure the model is as right as necessary. With this in mind, the following sections briefly address the techniques we used to ensure the correctness and quality of our simulation (Dabkowski et al, 2009).

9.1 Verification

Verification essentially answers the question, "Did we build the model right, or does our model operate the way we envisioned it?" While there are many ways to verify a model, we focused on using three techniques, namely iteration, animation, and numerical / graphical observation (Dabkowski et al, 2009).

Iteration: The model's current version is 58. This is a result of repeated testing. Each time a new version is updated, testing is conducted by running the simulation for each of the nine CMFs. When we would come across a run-time error, we would document it with a screenshot and e-mail it to our ProModel programmer. He would then do incremental testing, debugging, and retesting, using ProModel's embedded trace features as well as custom log files to fix the error. Using this thorough approach, we ensured the model was operating as desired.

Animation: While the use of graphics is aesthetically pleasing and useful for conveying a simulation's logic to decision makers, it also facilitates verification (Dabkowski et al, 2009). Our on-screen counters show the model is progressing through time, and we expect to see the numbers constantly update throughout the simulation run. There were a number of errors that were identified by watching the on-screen counters. If we did not have this animation enabled, we would have to wait until the end of the simulation run to start verification. Thus, the animation allowed us to immediately identify anomalies or inconsistencies with historical Army behavior by presenting pertinent information that can be assessed while the model was running.

Numerical and Graphical Observation: As a final check, we compared many numerical results to their required or expected values both throughout and at the end of the simulation runs. For instance, we checked to ensure that the number of Soldiers at the end of a run (by MOS and grade) roughly matched the number at the beginning, and that the contents of each unit closely mirrored its MTOE (Dabkowski et al, 2009).

That said, a picture is often worth a thousand debugging statements. As an example, we might want to ensure that the deploying units experience fill percentages that are consistent with AC Manning Guidance during their ARFORGEN manning cycles. Figure 10 verifies this nicely, as the BCT's actual fill percentages (blue lines) depicted over the time period shown hover between 80% and 105%. In sum, we are confident that we built the model right (Dabkowski et al, 2009).

9.2 Validation

Similar to verification, validation answers a question, namely, "Did we build the right model, or does our model mimic the real system closely enough for us to have confidence in its results?" Almost without exception, validating a model is much more difficult than verifying it. Nonetheless, we used the following techniques to establish the validity of our model: extensive use of primary source data, entity trace, and model comparison (Dabkowski et al, 2009).

Primary Source Data: From securing the AST from FORSCOM to using validated strength forecasts from PRS, we used and implemented primary source data whenever possible. While some might question this as a formal validation technique, many have advocated this approach in order to guarantee that the model has high face validity (Sargent, 1998). As an example, by resampling our (TIS, TIG, enlistment status) triples with replacement from the TAPDB, we maintained the underlying, statistical dependence of these parameters (Dabkowski et al, 2009).

Entity Trace: As a technique, entity trace essentially records the actions of an entity during a simulation run, so they can subsequently be compared to actual behaviors (Harrell et al., 2004). With this in mind, we performed both partial and complete entity traces throughout the model development (Dabkowski et al, 2009). In Figure 20, you will find output produced from the model that depicts the career progression of Soldier ID# 72662. You can quickly see that this 11B Soldier started getting tracked in our model as an E4 when he went downrange for the second time at the start of month 42 as a member of Unit 192 (which is the 21st Infantry Battalion in an SBCT). Then, he had 15 months of dwell time. At month 69, he was still in unit 192 and deployed for the third time for 12 months. At some point after the third deployment, he was promoted to E5 and PCS'ed to Unit 20 (1-82 FA 1-1CD HBCT). He got to enjoy 54 months of dwell before his fourth deployment started in month 135. Then, he was tracked again when he deployed a fifth time in month 168 as an E6 in Unit 30 (an HBCT Combined Arms Battalion), following 21 months of dwell. From this summary, we observed this Soldier was promoted, deployed, and reassigned in accordance with appropriate regulations. Moreover, given his 180 month career (15 years), it's certainly plausible that he would still be an E6 (though he is likely an E6(P)) and that he could have deployed 5 times.

	A	B	C	D	E	F	G	H
1	1	2	3	4	5	6	7	8
2	MOS	Grade	Unit	Unit Type	Sim Mo.	BOG Months	Dwell Months	Soldier ID
8941	13	4	192	2	42	12	16	72662
27237	13	4	192	2	69	12	15	72662
74469	13	5	20	3	135	12	54	72662
98231	13	6	30	3	168	12	21	72662

Figure 20: Screen shot of the career progression of Soldier ID# 72662

Model Comparison: Since MAJ Dabkowski and MAJ Zais spent a lot of effort in 2009 validating their model, it would be prudent for us to compare our 11 Series median BOG:Dwell ratios to theirs to make sure they are relatively close. Now, the demand scenario is not exactly the same, but they are similar. For example, one of the 11 Series scenarios that MAJ Dabkowski and MAJ Zais looked at was where the supply was 45 BCTs and the demand was 15 BCTs (8 IBCTs, 5 HBCTs, and 2 SBCTs). Their median BOG:Dwell ratio for this scenario was 1:1.3. Keep in mind that their steady-state assumptions were a little different than ours. For example, the RIP-TOA overlap in their scenario was 40 days. In ours, the RIP-TOA overlap was 25 days. This 15 days difference should improve the BOG:Dwell ratios in our scenario. Now, we modeled the 11 Series with the same supply (45 BCTs) but with a slightly different demand. Our demand was also 15 BCTs, but the make-up was different (8 IBCTs, 6 HBCTs, and 1 SBCT). Since SBCTs are nearly 2.5 times greater than HBCTs, we can conclude that our scenario is a slightly less demanding scenario (by 1.5 HBCTs) and thus the BOG:Dwell ratio should improve. With all that explanation, our 11 Series median BOG:Dwell ratio is 1:1.33. This gives us added confidence that we have built the right model.

10 FUTURE WORK

The more we show our model's capabilities to others, the more it generates widespread enthusiasm and support for a rigorous analysis of the Army's BOG:Dwell challenges. Predictably, with this awareness came additional requests for support. PRS already would like us to analyze five more critical CMFs (42 - Administrative, 68 - Medical, 88 - Transportation, 91 - Maintenance, 92 - Supply & Logistics). Additionally, the 37th Chief of Staff of the Army would like us to look at the effects of shortening deployments to nine months and what impact that would have on BOG:Dwell ratios. Finally, we have been asked to study the effects of different demand scenarios so we can answer questions regarding whether our current force structure can handle higher demand. With just a few inputs (AST schedule, force structure of the Active Component Army, and current policies), there are a myriad of questions we can answer with our model.

11 CONCLUSION

We have improved the model so that it is more scalable, streamlined, and efficient. First, we expanded the modeling capabilities to include the remaining BCT centric CMFs, which are 13 (Field Artillery) and 19 (Armor). Additionally, we analyzed the CAB centric MOSs, which included all specialties within CMF 15 (Aviation). Finally, and perhaps more importantly, we accomplished the critical task of incorporating selected critical enabler MOSs within the following CMFs: 12 (Engineers), 25 (Signal), 31 (Military Police), 35 (Military Intelligence), and 89 (Explosive Ordnance Disposal). As a result, this simulation is capable of both estimating the individual dwell statistics by grade for many critical MOSs and producing other residual unit manning and individual attribute statistics.

With contracted programming support from ProModel, the simulation run time has been significantly reduced. The largest CMF (11 Series) used to take over 27 hours to simulate, and now it can be simulated in less than 2 hours, which is 7% of the original run-time or a 1500% increase in speed.

One of the most interesting findings we uncovered (given the AC demand in our scenario) when considering the dwell years by grade, is that over 75% of E7s and below (in the nine CMFs we analyzed) do not get the 1:2 BOG:Dwell ratio that is desired. The 11 and 15 Series have it the worst, as 99% of the E8s and below in those two CMFs are not getting two years of dwell between deployments. Our results also suggest that if you are an E7 or E8 in the enabler CMFs (12, 25, 31, 35, & 89), you have a significantly better chance of getting two years of dwell. However, that chance is still below 50%. All in all, the Soldiers are being heavily taxed, regardless of their CMF.

If the Army wants to improve BOG:Dwell ratios, then they need to either reduce the demand for deployed Soldiers, increase the size of the Army, or change the policy regarding deployment lengths. If less deployed Soldiers are required, then BOG:Dwell ratios will improve. Also, if the size of the Army increases significantly, then more Soldiers can share in the deployments, thus improving individual BOG:Dwell ratios. And finally, if the Army adopted a policy of longer deployments, then the BOG:Dwell ratios would improve. It is worth pointing out that in this latter case, the Army should heavily consider the negative impacts a longer deployment would have on its Soldiers.

The result of this research is a realistic and useable simulation tool that can assist decision makers in analyzing the future effects of current and proposed demand, structure, and policy changes. As the international environment changes, this tool will allow decision makers to design policy which complies with applicable regulations, law, and procedures and to understand the effect of that Army-level policy on the individual Soldier.

APPENDIX A

The following nine figures (Figure 21-29) display the dwell years by MOS and grade for the nine CMFs (11, 13, 15, 19, 12, 25, 31, 35, and 89) we analyzed.

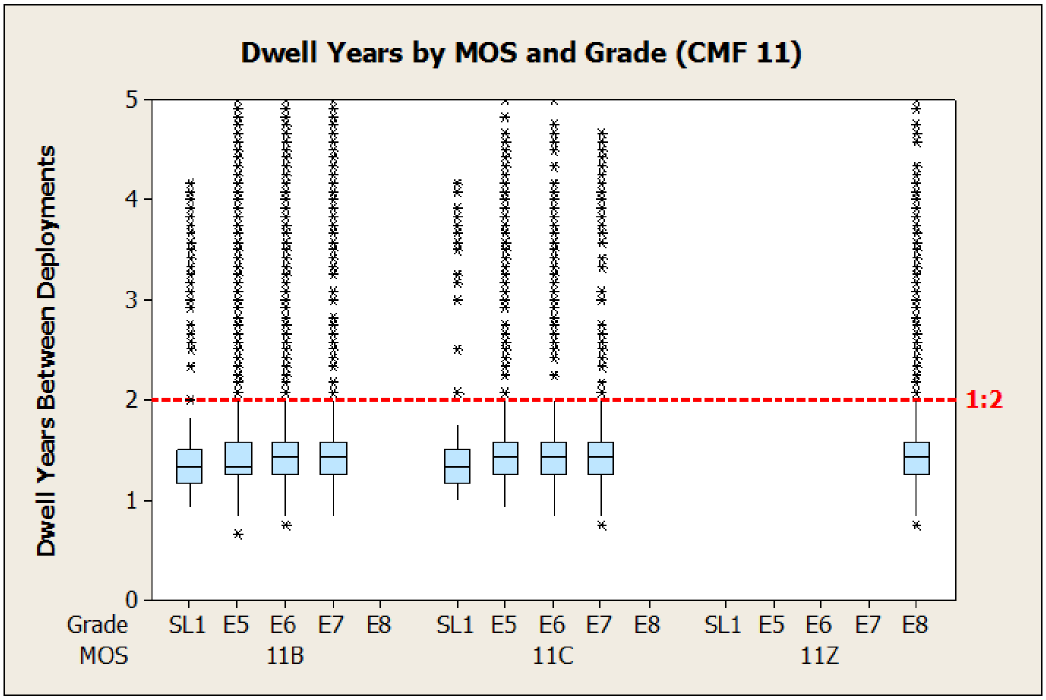


Figure 21: Dwell Years by MOS and Grade (CMF 11 – Infantry)

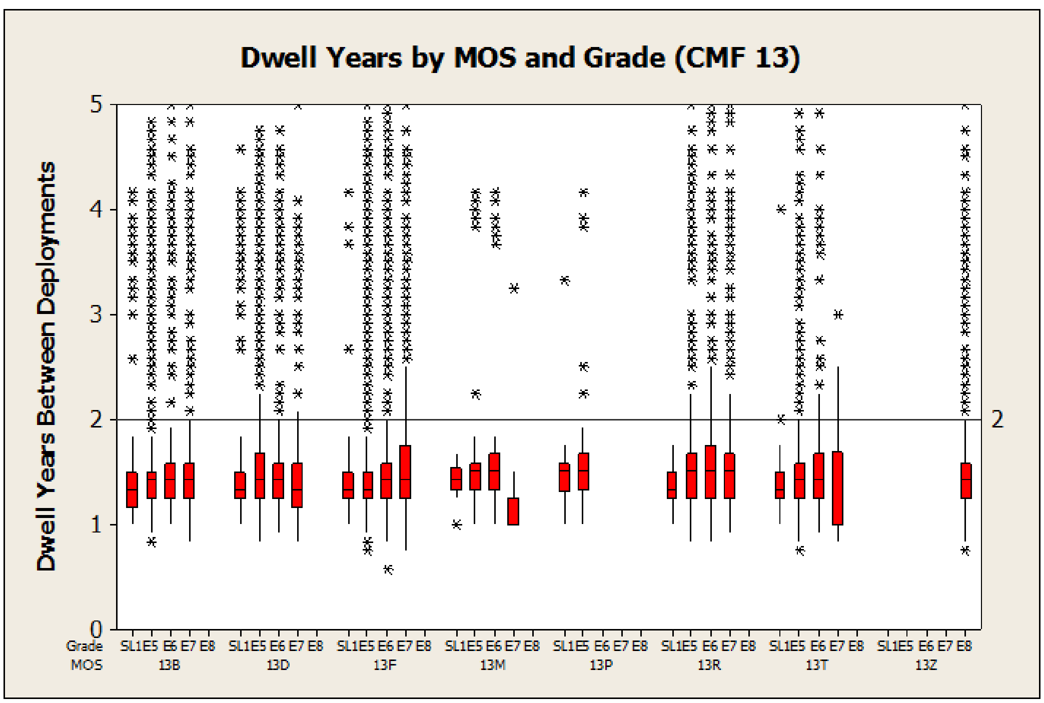


Figure 22: Dwell Years by MOS and Grade (CMF 13 – Field Artillery)

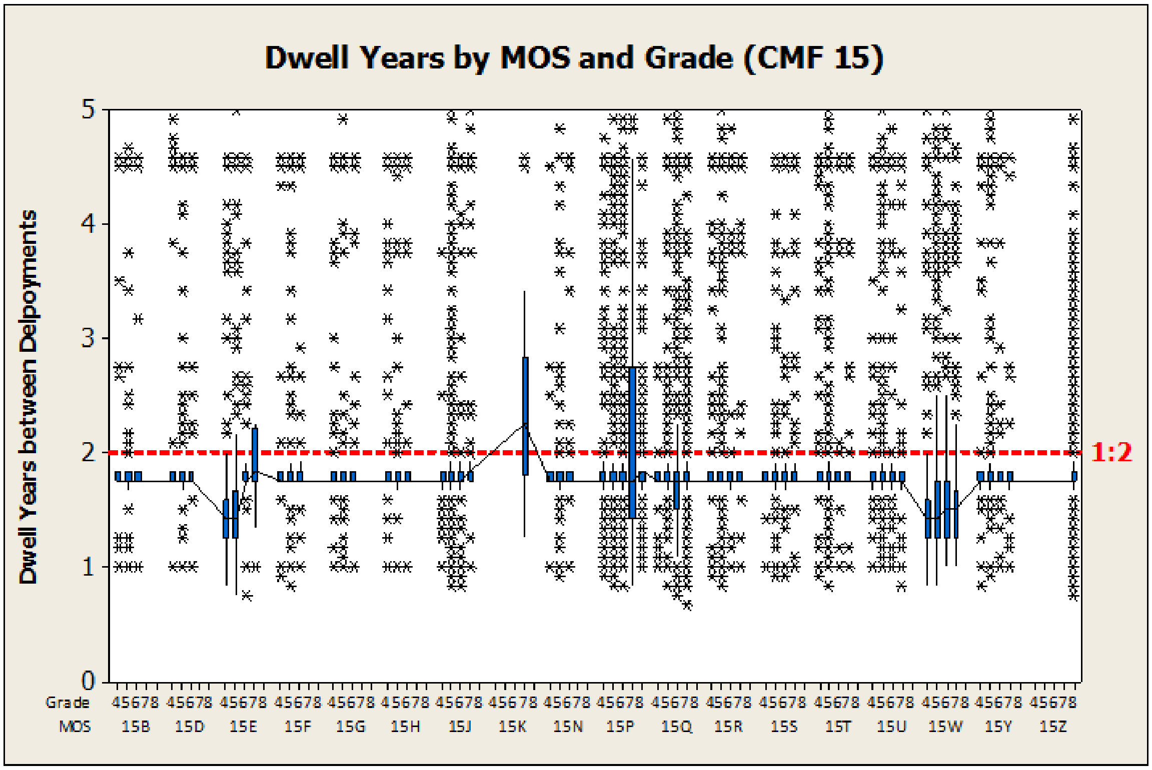


Figure 23: Dwell Years by MOS and Grade (CMF 15 – Aviation)

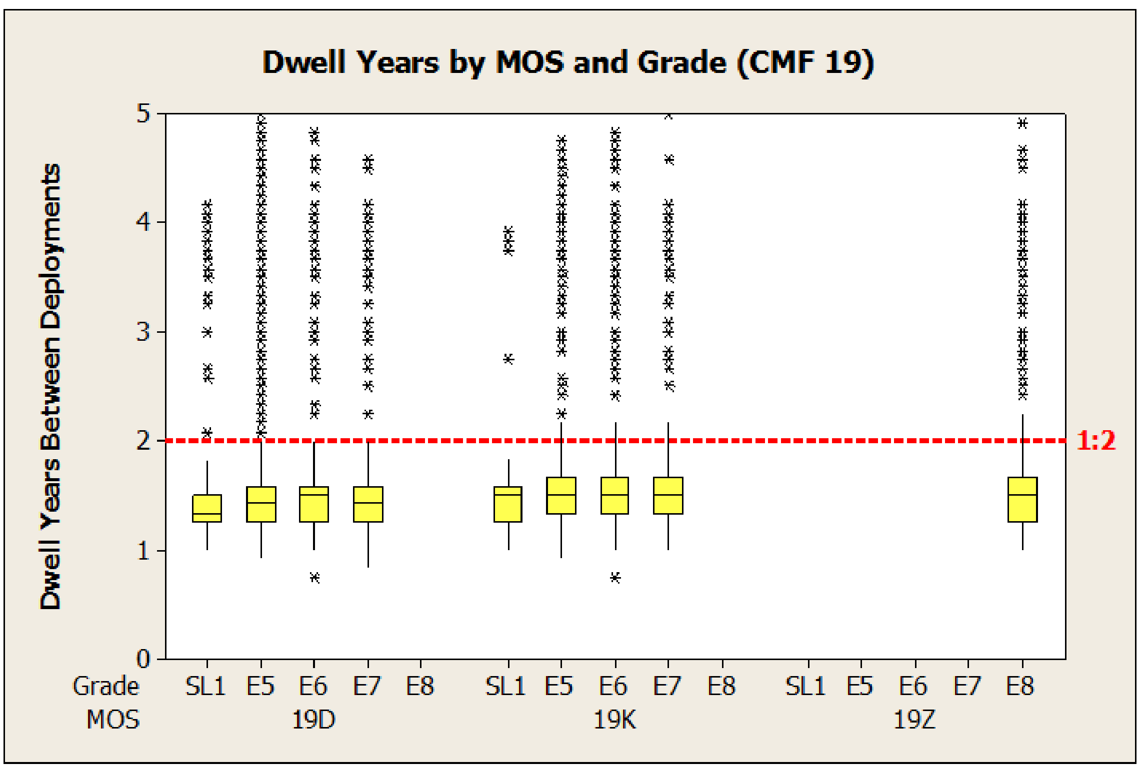


Figure 24: Dwell Years by MOS and Grade (CMF 19 – Armor)

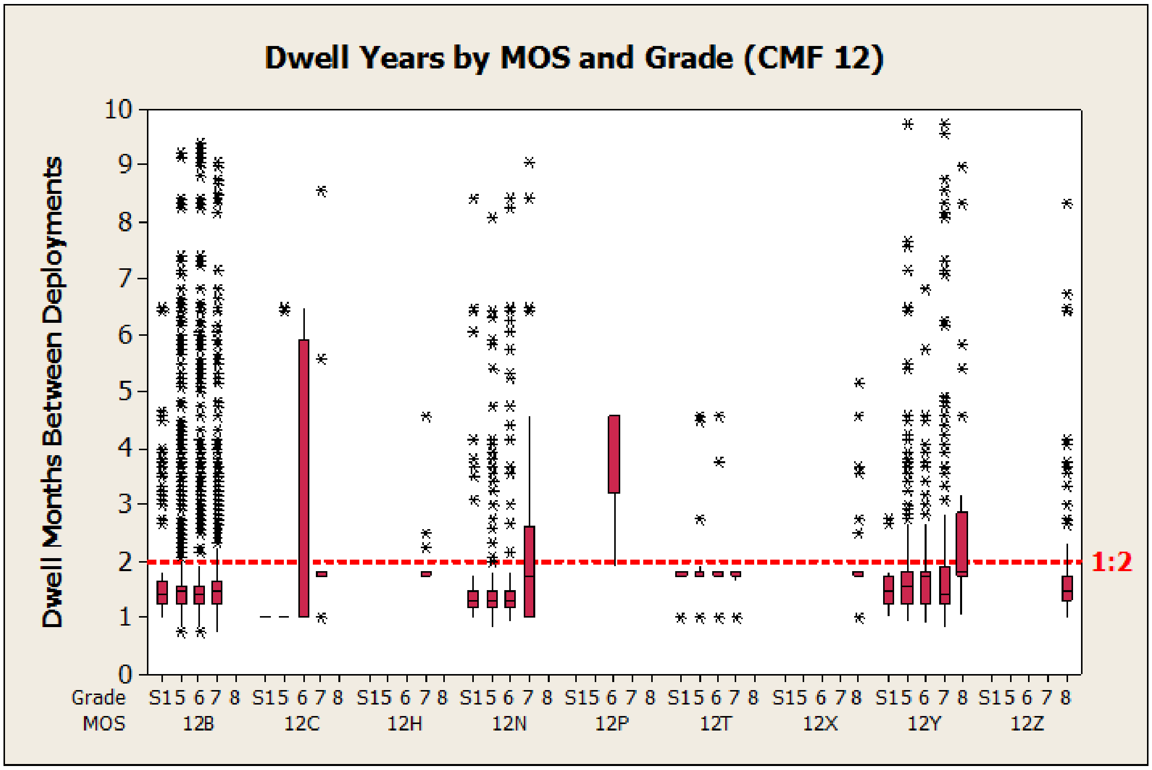


Figure 25: Dwell Years by MOS and Grade (CMF 12 – Engineers)

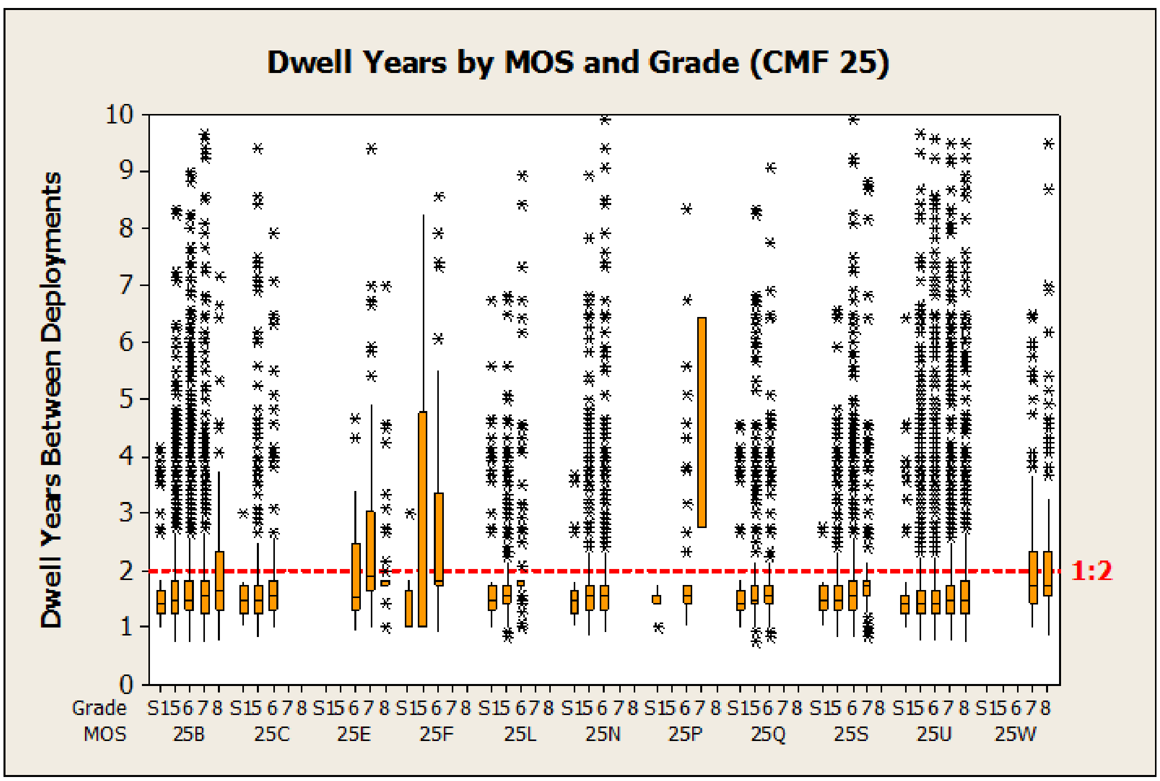


Figure 26: Dwell Years by MOS and Grade (CMF 25 – Signal)

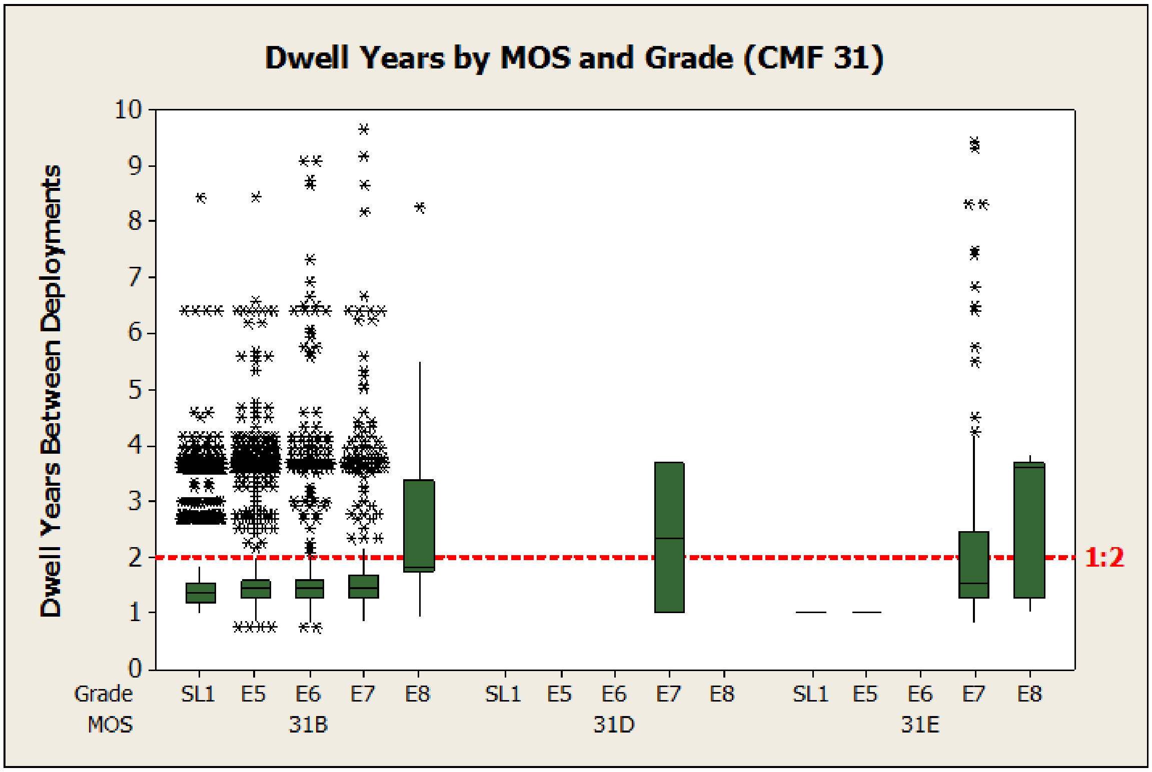


Figure 27: Dwell Years by MOS and Grade (CMF 31 – Military Police)

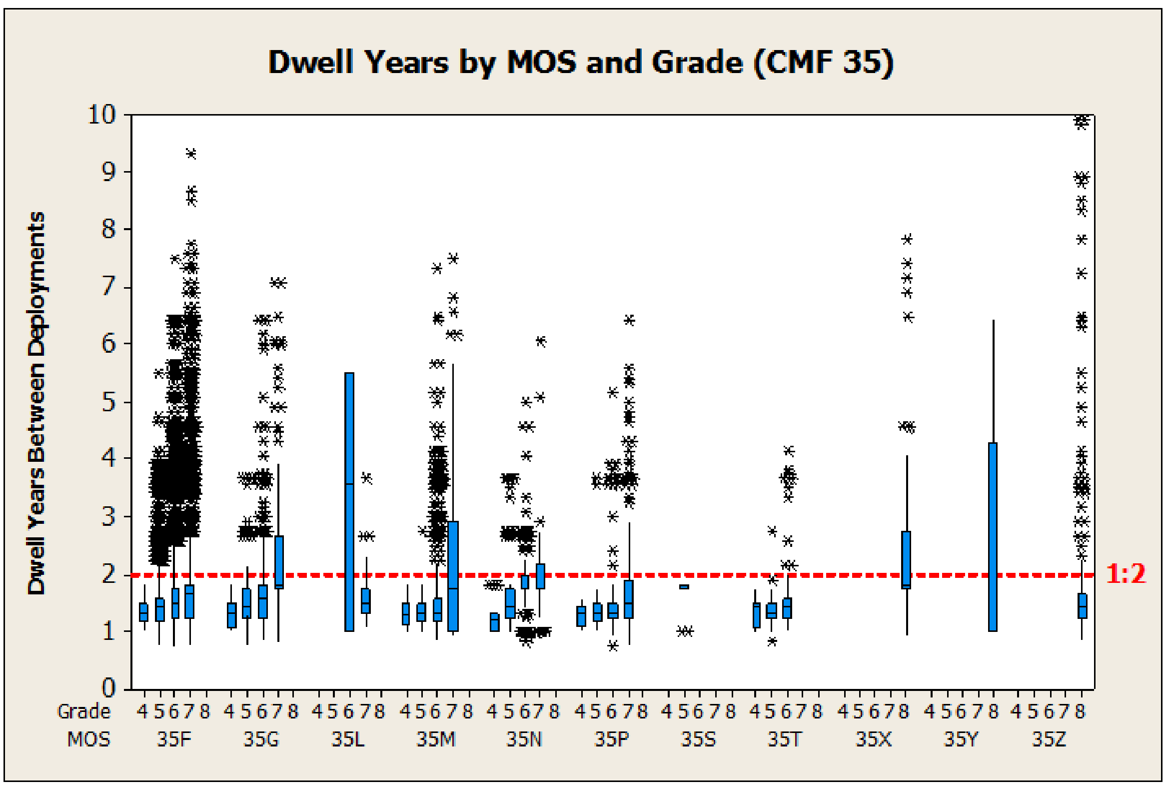


Figure 28: Dwell Years by MOS and Grade (CMF 35 – Military Intelligence)

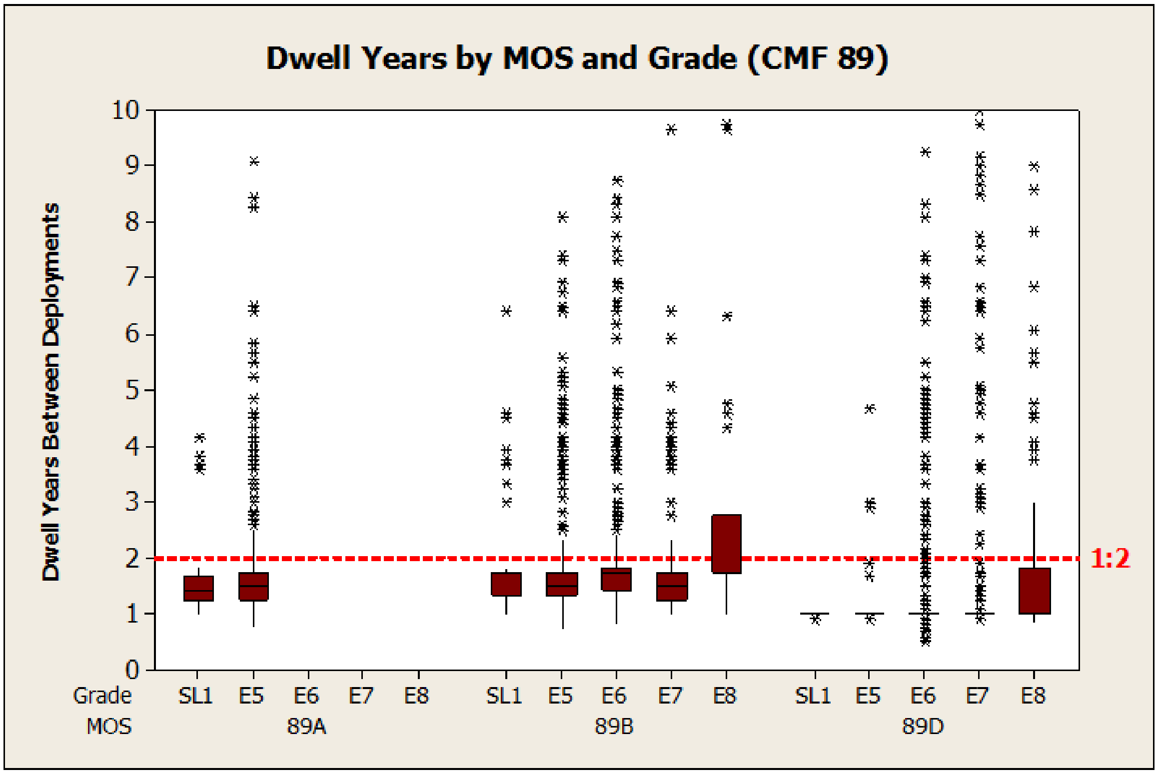


Figure 29: Dwell Years by MOS and Grade (CMF 89 – Explosive Ordnance Disposal)

REFERENCES

Dabkowski, Matt, Zais, Mark, Kwinn Jr., Michael J., Miller, Kent. 2009. *Analysis of Unit and Individual BOG:Dwell in Steady-State ARFORGEN.* Technical Report. Operations Research Center of Excellence.

Department of Defense. 2005 (12 January). *DODI 1315.18p: Procedures for Military Personnel Assignments.*

Department of the Army. 2005. *AR 635-200: Active Duty Enlisted Administrative Separations.*

Department of the Army. 2006. *AR 601-280: Army Retention Program.*

Department of the Army. 2007 (November). *ALARACT 253/2007: Individual Dwell Time (IDT) Deployment Policy*.

Department of the Army. 2008a (10 April). *Active Army Twelve Month Boots On The Ground (BOG) Policy*.

Department of the Army. 2008b. *AR 600-8-19: Enlisted Promotions and Reductions.*

Department of the Army. 2008c (10 July). *HQDA Active Component Manning Guidance for FY 2008-2010.*

Department of the Army. 2008d (29 August). *MILPER Message Number: 08-219 (AHRC-PL-PN) ARFORGEN Focused Manning.*

Department of the Army. 2011 (14 March). *AR 525-29: Army Force Generation.*

Harrell, Charles, Ghosh, Biman K., & Bowden Jr., Royce O. 2004. *Simulation Using ProModel.* Second edn. McGraw Hill, New York.

Parnell, Gregory S., Driscoll, Patrick J., & Henderson, Dale L. (eds). 2011. *Decision Making in Systems Engineering and Management.* Second edn. Wiley Series in Systems Engineering and Management. John Wiley & Sons, Inc.

Sargent, Robert G. 1998. Verification and Validation of Simulation Models.

GLOSSARY

AC	Active Component
ACP	Army Campaign Plan
AFM	ARFORGEN Focused Manning
AHRC	Army Human Resources Command
ARFORGEN	Army Force Generation
AST	ARFORGEN Synchronization Tool
BASD	Basic Active Service Date
BCT	Brigade Combat Team
BOG	Boots on the Ground
CAA	Center for Army Analysis
CAB	Combat Aviation Brigade
CMF	Career Management Field
CONUS	Continental U.S.
DA	Department of the Army
DoD	Department of Defense
ETS	Expiration Term of Service
FMSWeb	Force Management System Website
FORSCOM	U.S. Forces Command
FSA	Force Structure Allowance
FY	Fiscal Year
GWOT	Global War on Terror
HBCT	Heavy Brigade Combat Team
IBCT	Infantry Brigade Combat Team
IDEF0	Integration Definition for Function Modeling Diagram
IDT	Individual Dwell Time
LAD	Latest Arrival Date
MOS	Military Occupational Specialties
MRE	Mission Rehearsal Exercise
MTOE	Modified Table of Organization and Equipment
OCONUS	Outside the Continental U.S.
ORCEN	Operations Research Center of Excellence
OS	Operating Strength
PCS	Permanent Change of Station
PMAD	Personnel Management Authorization Document
PRS	Plans and Resources Directorate of the Army G1
R	Return Date
RCP	Retention Control Point
SBCT	Stryker Brigade Combat Team
SL1	Skill Level 1
TAPDB	Total Army Personnel Database
TDA	Table of Distribution and Allowances
TOS	Time on Station
UAD	Updated Authorization Document
UIC	Unit Identification Code
VCSA	Vice Chief of Staff of the Army

Distribution List

The list indicates the complete mailing address of the individuals and organizations receiving copies of the report and the number of copies received. Due to the Privacy Act, only use business addresses; no personal home addresses. Distribution lists provide a permanent record of initial distribution. The distribution information will include the following entries:

NAME/AGENCY	ADDRESS	COPIES
Author(s)	**Department of Systems Engineering Mahan Hall West Point, NY 10996**	**2**
Client	**Army G1 Plans and Resources Directorate 300 Army Pentagon Washington, DC 20310-0300**	**2**
Dean, USMA	**Office of the Dean Building 600 West Point, NY 10996**	**1**
Defense Technical Information Center (DTIC)	**ATTN: DTIC-O Defense Technical Information Center 8725 John J. Kingman Rd, Suite 0944 Fort Belvoir, VA 22060-6218**	**1**
Department Head-DSE	**Department of Systems Engineering Mahan Hall West Point, NY 10996**	**1**
ORCEN	**Department of Systems Engineering Mahan Hall West Point, NY 10996**	**5**
ORCEN Director	**Department of Systems Engineering Mahan Hall West Point, NY 10996**	**1**
USMA Library	**USMA Library Bldg 757 West Point, NY 10996**	**1**

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. REPORT DATE *(DD-MM-YYYY)*	2. REPORT TYPE	3. DATES COVERED *(From - To)*
11072100	Final	11072010-11072011

4. TITLE AND SUBTITLE
ARFORGEN BOG:Dwell Simulation

5a. CONTRACT NUMBER

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)
MAJ David Hughes
MAJ Mark Zais
LTC Paul Kucik
COL Fernando Huerta

5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
USMA Operations Research Center of Excellence, West Point, NY
Army G1, Military Strength Analysis and Forecasting

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
Army G1, Military Strength Analysis and Forecasting

10. SPONSOR/MONITOR'S ACRONYM(S)

11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
A- Approved for Public Release; Distribution Unlimited

13. SUPPLEMENTARY NOTES

14. ABSTRACT
The Army refers to the time a Soldier spends deployed overseas in a combat environment as Boots on the Ground time, or BOG. Conversely, the time a Soldier spends between deployments is known as “dwell.” This BOG:Dwell ratio is an important, highly visible statistic, that serves as a leading indicator of recruiting, retention, and morale issues for the Army, its Soldiers, and their families. The Army G1’s Strength Analysis and Forecasting Division in the Plans and Resources Directorate (PRS) and the Department of Systems Engineering’s Operations Research Center of Excellence (ORCEN) were tasked to expand the capability of the existing BOG:Dwell model to both estimate the individual dwell statistics by grade for many critical Military Occupational Specialties (MOSs) and produce other residual unit manning and individual attribute statistics. Additionally, this past year’s efforts focused on improving the model so that it was more scalable, streamlined, and efficient.

15. SUBJECT TERMS
ARFORGEN, BOG:Dwell, Discrete-Event Simulation, Personnel Modeling, Strength Forecasting

16. SECURITY CLASSIFICATION OF: a. REPORT	b. ABSTRACT	c. THIS PAGE	17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
Unclassified	Unclassified	Unclassified	UL	37	LTC Paul Kucik
					19b. TELEPHONE NUMBER *(Include area code)* 845-938-5529

Reset

INSTRUCTIONS FOR COMPLETING SF 298

1. REPORT DATE. Full publication date, including day, month, if available. Must cite at least the year and be Year 2000 compliant, e.g. 30-06-1998; xx-06-1998; xx-xx-1998.

2. REPORT TYPE. State the type of report, such as final, technical, interim, memorandum, master's thesis, progress, quarterly, research, special, group study, etc.

3. DATES COVERED. Indicate the time during which the work was performed and the report was written, e.g., Jun 1997 - Jun 1998; 1-10 Jun 1996; May - Nov 1998; Nov 1998.

4. TITLE. Enter title and subtitle with volume number and part number, if applicable. On classified documents, enter the title classification in parentheses.

5a. CONTRACT NUMBER. Enter all contract numbers as they appear in the report, e.g. F33615-86-C-5169.

5b. GRANT NUMBER. Enter all grant numbers as they appear in the report, e.g. AFOSR-82-1234.

5c. PROGRAM ELEMENT NUMBER. Enter all program element numbers as they appear in the report, e.g. 61101A.

5d. PROJECT NUMBER. Enter all project numbers as they appear in the report, e.g. 1F665702D1257; ILIR.

5e. TASK NUMBER. Enter all task numbers as they appear in the report, e.g. 05; RF0330201; T4112.

5f. WORK UNIT NUMBER. Enter all work unit numbers as they appear in the report, e.g. 001; AFAPL30480105.

6. AUTHOR(S). Enter name(s) of person(s) responsible for writing the report, performing the research, or credited with the content of the report. The form of entry is the last name, first name, middle initial, and additional qualifiers separated by commas, e.g. Smith, Richard, J, Jr.

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES). Self-explanatory.

8. PERFORMING ORGANIZATION REPORT NUMBER. Enter all unique alphanumeric report numbers assigned by the performing organization, e.g. BRL-1234; AFWL-TR-85-4017-Vol-21-PT-2.

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES). Enter the name and address of the organization(s) financially responsible for and monitoring the work.

10. SPONSOR/MONITOR'S ACRONYM(S). Enter, if available, e.g. BRL, ARDEC, NADC.

11. SPONSOR/MONITOR'S REPORT NUMBER(S). Enter report number as assigned by the sponsoring/ monitoring agency, if available, e.g. BRL-TR-829; -215.

12. DISTRIBUTION/AVAILABILITY STATEMENT. Use agency-mandated availability statements to indicate the public availability or distribution limitations of the report. If additional limitations/ restrictions or special markings are indicated, follow agency authorization procedures, e.g. RD/FRD, PROPIN, ITAR, etc. Include copyright information.

13. SUPPLEMENTARY NOTES. Enter information not included elsewhere such as: prepared in cooperation with; translation of; report supersedes; old edition number, etc.

14. ABSTRACT. A brief (approximately 200 words) factual summary of the most significant information.

15. SUBJECT TERMS. Key words or phrases identifying major concepts in the report.

16. SECURITY CLASSIFICATION. Enter security classification in accordance with security classification regulations, e.g. U, C, S, etc. If this form contains classified information, stamp classification level on the top and bottom of this page.

17. LIMITATION OF ABSTRACT. This block must be completed to assign a distribution limitation to the abstract. Enter UU (Unclassified Unlimited) or SAR (Same as Report). An entry in this block is necessary if the abstract is to be limited.