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Analyzing Candidate Throughput and Instructor Utilization in the Special Forces Pipeline

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Abstract: The U.S. Army John F. Kennedy Special Warfare Center and School (USAJFKSWCS or SWCS) develops Special Forces (SF) Soldiers through a rigorous training pipeline, consisting of several specialized courses. SWCS is considering changing the scheduling and frequency of these courses, with the aim of improving the pipeline's overall efficiency while minimizing negative impacts to its instructors and infrastructure. This study uses value modeling and discrete event simulation (DES) to design, test, and evaluate potential changes to the SF pipeline. Using DES, the team first created a baseline model of the current pipeline. The team then developed four experiments that varied course scheduling, course capacity, and student entry rates. Finally, the team analyzed and evaluated the baseline model and experiments along three value measures. This research provides insight into the pipeline and expected impact of scheduling changes, as well as recommendations for refining the model and further schedule development and evaluation.

Keywords: Special Warfare Center and School, Special Forces, ProModel, Discrete Event Simulation

1. Introduction

The mission of the United States Army John F. Kennedy Special Warfare Center and School (USAJFKSWCS or SWCS) is to produce world-class Army Special Operations Forces (ARSOF) soldiers which includes Special Forces, Civil Affairs, and Psychological Operations (USAJFKSWCS, 2023). Moreover, SWCS must produce enough Special Forces (SF) Operators, also known as "Green Berets", annually to meet the demands of 1st Special Forces Command's five active-duty SF Groups and two National Guard SF Groups (SWCS G3, 2023).

To become a Green Beret, candidates must complete the SF Pipeline, a sequence of specialized training courses. The SF Pipeline produces five different SF Operators – SF Officers, SF Weapons Sergeants, SF Engineer Sergeants, SF Medical Sergeants, and SF Communication Sergeants (Special Operations Recruiting, 2023). Depending on the candidate's military occupational specialty (MOS), a candidate will complete seven to eight courses before finishing the pipeline and joining their first unit (SWCS G3, 2023). SWCS accomplishes this feat by having four major starts to the SF Pipeline each year, also known as the 4-start model. It will take a candidate 12-18 months (depending on their MOS and assigned language) to go straight through the pipeline. Recycling a course will dramatically increase the time that a candidate remains in the pipeline.

This research project will use the Systems Decision Process (SDP) as a framework to develop and analyze potential scheduling solutions to improve pipeline throughput while minimizing the negative impact on instructors. The Systems Decision Process consists of four major phases: Problem Definition, Solution Design, Decision-Making, and Solution Implementation (Parnell, 2011). This research project will conclude at the end of the third phase.

2. Problem Definition

The Problem Definition Phase began with stakeholder interviews and research using scholarly articles and DoD digital systems. The team sought to understand the pipeline's course structure and sequencing and SWCS' key values and objective measures. The team also completed a literature review on Special Operations Forces, discrete event simulation, training methods, resource utilization and optimization strategies, and organizational change. Stakeholder interviews helped define the requirements and create a functional analysis of the pipeline. The interviews identified key requirements and constraints for course sequencing, scheduling, and instructor utilization. The Force Management System (FMSWeb) provided data on SWCS manning authorizations. The Army Training Requirements and Resources System (ATRRS) provided key scheduling information, including course start and end dates, course duration, and course capacities for every course occurring between Fiscal Year 2019 and 2023 (ATRRS, 2023).

SWCS is currently working to improve the throughput of its SF Pipeline by changing its course scheduling to reduce candidate wait times between courses. SWCS is considering a 5-start model compared to its current 4-start model. However, SWCS is concerned that the increased workload placed on their instructors could lead to instructor fatigue, which is not only bad for long-term individual health, but could also reduce the quality of instruction (SWCS G3, 2023). Poor instruction could lead to increased recycle rates or lower-quality SF soldiers entering the SF Regiment. Figure 1 shows the initial value model developed during the Problem Definition Phase. After considering SWCS' priorities, available data, and other key constraints, the team chose to focus its research on four value measures (outlined in green): annual number of graduates, candidate wait time in queue, instructor utilization per course, and student-to-instructor ratio.

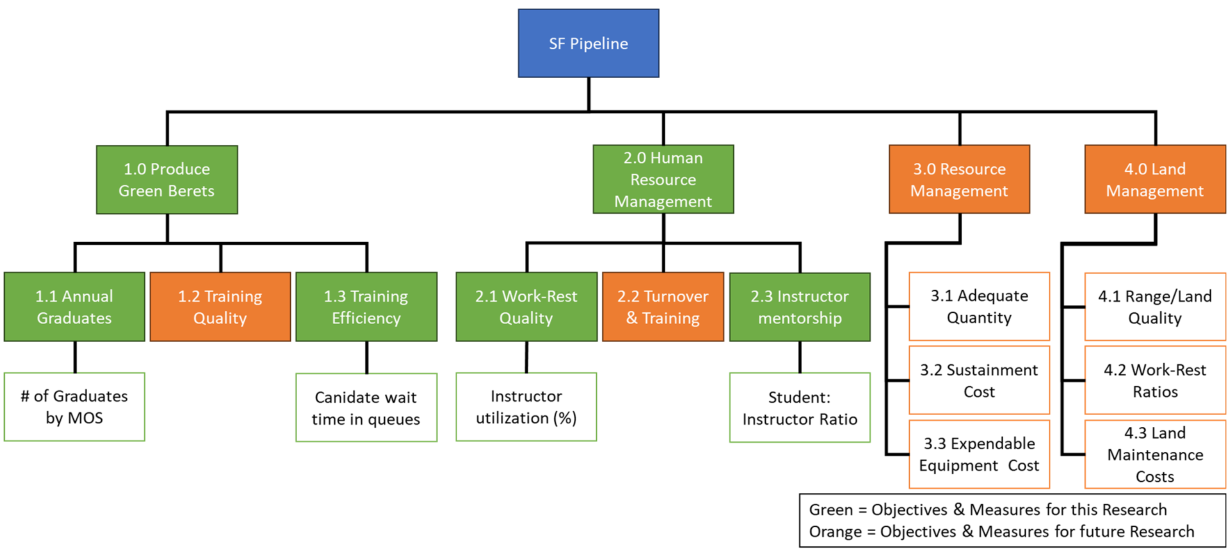

Figure 1: Value Model

3. Solution Design

3.1 Scheduling

The Solution Design Phase consisted of three major efforts – schedule development, experiment building, and simulation modeling. The team used Microsoft Project's scheduling software to develop an 8-year schedule that followed the scheduling rules of the current pipeline, including the timing of the annual four iterations, scheduled delays between sequenced courses, and course durations. Next, the team created an 8-year schedule for a 5-start model. This 5-start schedule compressed much of the time available between sequenced courses and course iterations, without altering course durations, graduation/recycle rates, course sequencing, and student-instructor ratios. This schedule, like the baseline schedule, only allowed the language course to have multiple classes running simultaneously. Later, after analyzing the results of the first three experiments (discussed in section 4), the team developed a second 5-start schedule that did allow select courses to have two classes running simultaneously. This "5-start overlap" schedule was feasible as the simulation results from Experiments 1-3 showed that instructor utilization for select courses remained below 50%. This indicated that the course had enough instructors to run two classes simultaneously. This "5-start overlap" schedule was evaluated in Experiment 4.

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3.2 Modeling

The team worked with a simulation expert to develop a Discrete Event Simulation (DES) model of the SF Pipeline using ProModel. Figure 2 shows the complete SF Pipeline. Some courses are required for all SF candidates, while others are MOS-specific.

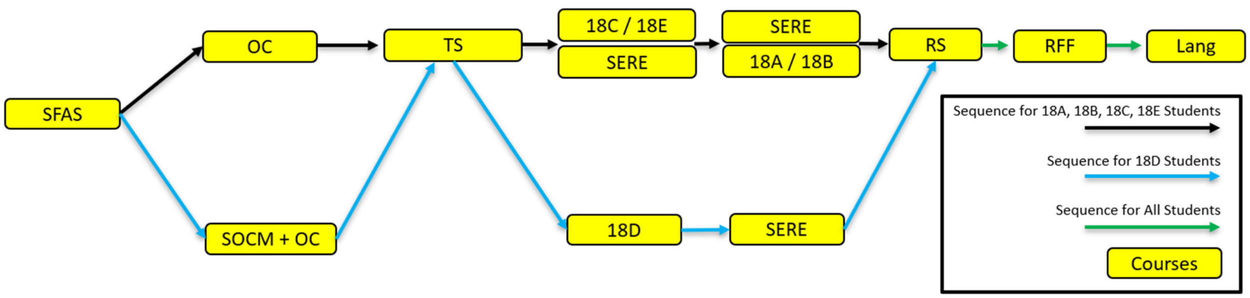

Figure 2: Overall SF Pipeline

Working with SWCS, the team identified that their research would focus on the core of the SF pipeline, shown in yellow in Figure 3. The grey-colored courses in Figure 3 would not be modeled; however, their impact on the rest of the pipeline would still be included. For example, the number of 18D students (Blue Arrow) attending Tactical Skills (TS) and Robin Sage (RS) would be accounted for in the arrival and processing logic. The ProModel simulation modeled the graduation, recycle, and drop rates, instructor availability, and required instructor-to-student ratios. Low probability outcomes, like serious injuries requiring surgery or personal events that require a student to be removed temporarily from the course, were not modeled. The model passed verification, but validation testing revealed the model slightly outperformed real-world data. For example, it had higher annual graduates and lower average course wait times. As a result, the team used the model to evaluate and compare courses of action rather than estimating future projections. Recommendations for model improvement are discussed in section 5.

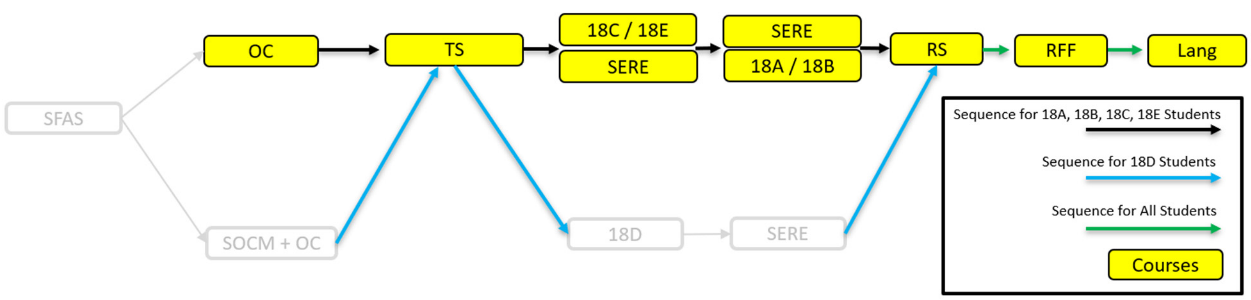

Figure 3: Core Pipeline Modeled

3.3 Experiment Building

The team developed three experiments to evaluate different scenarios for the 5-start model. Experiment 1 modeled a pipeline where the student arrival rates remained unchanged in comparison to the 4-start baseline. This resulted in an overall increase in the annual number of students entering the pipeline, as there are more pipeline starts in the 5-start schedule. Experiment 2 modeled a pipeline where the annual number of students remained unchanged, effectively reducing the student

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arrival rate, and reduced the course capacities. Experiment 3 modeled a pipeline where the annual number of students remained unchanged, effectively reducing the student arrival rate, but did not alter course capacities. After analyzing the results of the first three experiments, the team developed a fourth experiment that used the "5-start overlap" schedule discussed in section 3.1. Experiment 4 modeled a pipeline where the annual number of students remained unchanged, course capacities were reduced, and MOS-specific courses could have two classes running simultaneously. Table 1 summarizes the differences between the baseline and the experiments.

Table 1: Differences Between the Baseline and Experiment Schedules

	Baseline	**Experiment 1**	**Experiment 2**	**Experiment 3**	**Experiment 4**
Schedule-Type (4-start or 5-start)	4	5	5	5	5
Courses with Allowed Overlap	Language Courses Only	Language Courses Only	Language Courses Only	Language Courses Only	MOS-specific Courses & Language Courses
Course Capacities	--	No Change	Reduced 20%	No Change	Reduced 20%
# Students Beginning Each Iteration	--	No Change	Reduced 20%	Reduced 20%	Reduced 20%

4. Analysis

4.1 Annual Graduates

The average annual graduates per fiscal year was calculated using the results from the simulation. The results can be seen below in Table 2. Experiment 1 produced the most graduates. This is due to the fact that the student arrival rates remained unchanged, but the number of pipeline starts increased. Experiment 2 and 3 produced the same annual graduates as they had the same input variables and Experiment 2's course capacity reduction did not play a significant role in limiting student throughput. Moreover, the team discovered that the 5-start schedule did not always have five starts per year. Course lengths and scheduling constraints prevented five pipeline starts from always fitting into a 52-week year. As a result, these experiments were running smaller classes, with only some years having five graduations, while other years having four graduations. Experiment 4, with its overlapping courses, allowed five starts and graduations per fiscal year. Its average annual number of graduates was nearly identical to the baseline.

Table 2: Average Annual Graduates Results

Average Annual Graduates	
Baseline	832.7
Exp 1	901.3
Exp 2	728.0
Exp 3	728.0
Exp 4	839.0

4.2 Instructor Utilization

Analysis identified two course trends: 1) TS and RS, which consistently had instructor utilization rates over 50%, and 2) the MOS-specific courses, which consistently had instructor utilization rates below 50%. The instructor utilization rate for each course can be seen below in Figure 4. Reductions in instructor utilization rates were consistent with reductions in student arrival rates.

After seeing that Experiment 4 was both feasible and produced more graduates annually, compared to Experiments 1-3, the team ran a sensitivity analysis on Experiment 4. The team reduced the number of available instructors from 100% to 70% to test when the "5-start overlap" schedule was no longer feasible. As there were no scheduled overlapping classes for TS and RS in the "5-start overlap" schedule, each course class could utilize all available instructors (e.g., up to 100%). However, since the "5-start overlap" schedule could have two simultaneous classes running for the MOS-specific courses, instructor utilization for each course class could not exceed 50%. Table 3 shows the results of an analysis. The results of this analysis show that, while Experiment 4 is feasible, a drop in manning would quickly push instructor utilization rates to their limits.

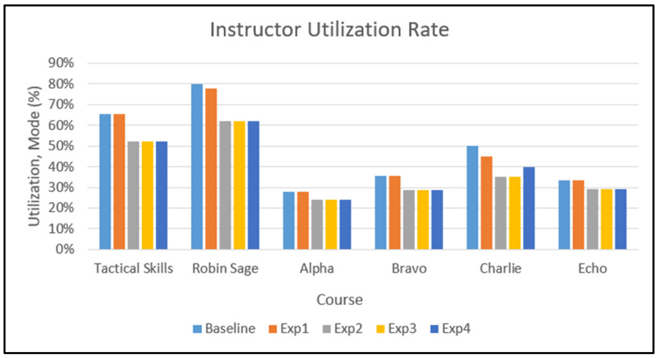

Figure 4: Instructor Utilization Results

Table 3: Experiment 4 Instructor Utilization Results

Instructor Utilization for Exp4 (while course in session)				
Manning Level:	100%	90%	80%	70%
Tactical Skills, AVG	52.1%	57.9%	65.2%	74.5%
Mode	52.2%	58.0%	65.3%	74.6%
Robin Sage, AVG	62.1%	69.0%	77.7%	88.8%
Mode	62.0%	68.9%	77.5%	88.6%
18A MOS, AVG	23.8%	26.5%	29.8%	34.0%
Mode	24.0%	26.7%	30.0%	34.3%
18B MOS, AVG	28.3%	31.5%	35.4%	40.5%
Mode	28.6%	31.7%	35.7%	40.8%
18C MOS, AVG	37.1%	41.2%	46.4%	53.0%
Mode	40.0%	44.4%	50.0%	57.1%
18E MOS, AVG	28.2%	31.4%	35.3%	40.3%
Mode	29.2%	32.4%	36.5%	41.7%

4.3 Course Queue Wait Time

The 5-start schedule used in Experiments 1-3 produced the lowest average wait times for courses. Additionally, the wait time histograms revealed very little variability in wait times. In fact, the MOS-specific courses had no variability. This resulted from the fact that an MOS-specific class always ended on the same Friday as its preceding course, along with a new MOS-specific class starting on the following Monday. This allowed graduates from the preceding course to immediately flow into the next MOS-course, while recycles from the MOS-course could restart the course again. The schedules for the Baseline and Experiment 4 do not have these tightly aligned schedules, so they maintain some variability in wait times, as illustrated in Figure 6. In all cases, the longer wait times are associated with recycled candidates waiting for the start of the next class.

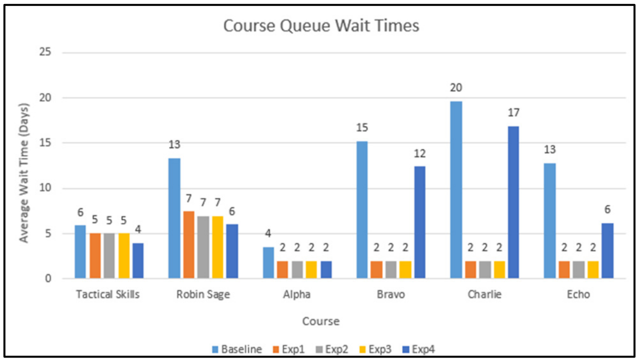

Figure 5: Average Course Wait Time Results

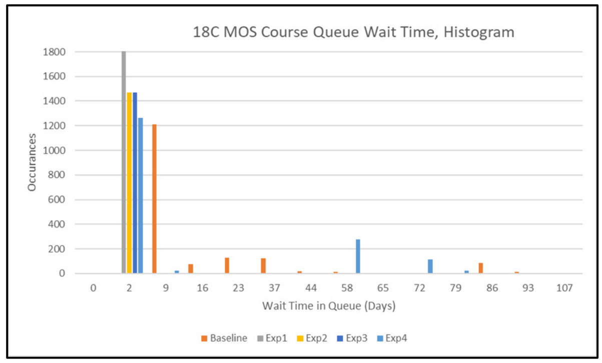

Figure 6: 18C MOS Course Wait Times

5. Discussion and Future Research

The analysis revealed that alternate pipeline schedules can improve throughput, wait times, and instructor utilization. Further schedule development should be based on expected future student backlog, arrival rates, and instructor manning levels. If SWCS expects a future backlog of students trying to begin the pipeline, then further development of an Experiment 1 schedule (increased pipeline starts while maintaining student arrival rates) may be best, as it could greatly increase the number of annual graduates. If future instructor manning is a concern, then development of an Experiment 2 or 3 schedule may be best. These experiments had the lowest instructor utilization rates, but did result in a decrease in overall annual graduate quantities – a tradeoff SWCS will have to consider. Expanding upon an Experiment 4 schedule may be best if SWCS wants to maintain, or possibly even increase, the annual number of graduates, but also believes its instructor manning levels will not drop in the future.

Future research should also focus on incorporating the rest of the SF Pipeline into the model. This will give SWCS a more informed and complete understanding of the impact that change has on the pipeline. The inclusion of resource management will provide a comprehensive view of the cost of key resources, further enriching the simulation model. The addition of instructor climate feedback from current instructors can provide valuable insight into instructor burnout, and will aid in identifying better utilization limits, instructor-to-student ratios, and other model constraints. Developing more accurate distributions for the model's inputs will yield more accurate model results in the future.

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