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Strength in Numbers: Using Simulation to Improve the Utilization of Training Facilities and Coaching at HP Forge

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Abstract: The Human Performance and Force Generation (HP Forge) facility at Fort Bragg supports the physical readiness of personnel at the U.S. Army John F. Kennedy Special Warfare Center and School (USAJFKSWCS or SWCS). This study applied the Systems Decision Process and Discrete Event Simulation to analyze facility utilization and coaching staff levels. Three scenarios were modeled to evaluate throughput, overcrowding, and coach-to-student ratios under varying participation conditions. Scenario analysis revealed that HP Forge can significantly increase student throughput by distributing workout times and adjusting course engagement strategies. Coach coverage analysis showed that current coach staff levels are sufficient for current participation levels and if HP Forge implements a pilot program to increase participation with select courses. Analysis also showed that SWCS can double daily throughput with minimal periods of overcrowding. The findings from this research will help inform SWCS in improving future facility utilization while maintaining an effective coaching staff.

Keywords: Human Performance, HP Forge, Special Operations Forces, Special Warfare Center and School, Discrete Event Simulation, Physical Training Optimization

1. Introduction

1.1 Background

The U.S. Army John F. Kennedy Special Warfare Center and School (USAJFKSWCS or SWCS) is the premier education and training institution for the U.S. Army's Special Operations Forces. It plays a critical role in enhancing the capabilities of U.S. Army Special Operations Command (USASOC) through specialized training and development of the Army's Special Forces (SF), Civil Affairs (CA), and Psychological Operations (PSYOP) students (USAJFKSWCS, 2024). To support this critical mission, SWCS has recently opened a single state-of-the-art training complex, the Human Performance and Force Generation (HP Forge) facility, at Fort Bragg.

HP Forge is a 90,000-square-foot center dedicated to optimizing soldier performance through strength training, rehabilitation, cognitive resilience, and performance nutrition. It integrates advanced sports science research and collaborates with United States Special Operations Command (USSOCOM) and other institutions to enhance training effectiveness (Morningstar, 2024). This study focuses specifically on HP Forge's strength training and condition program, using the Systems Decision Process (SDP) as a framework for analyzing the complexities of capacity and staffing and providing recommendations for improving utilization.

1.2 Systems Decision Process

The Systems Decision Process (SDP) served as the foundational methodology for this project, guiding the team through a structured approach to address the complex scheduling and staffing challenges at HP Forge. This project utilized the first three phases of the SDP—Problem Definition, Solution Design, and Decision-Making—to ensure a comprehensive understanding of the problem and to develop and evaluate potential recommendations (Parnell et al. 2011). In the Problem Definition phase, the team conducted a literature review, stakeholder interviews, and a means-objective analysis to identify key performance criteria and stakeholder needs. This research guided model development and scenario testing and ensured analyses reflected stakeholder priorities. During the Solution Design phase, the team built a Discrete Event Simulation (DES) model using

ProModel® simulation software and developed three scenarios for testing. In the Decision-Making phase, the team evaluated the three scenarios, providing HP Forge with valuable insights into the future utilization of its facility and coach staffing levels.

2. Problem Definition

2.1 Literature Review

The literature review for this project provided valuable insights into professional strength training and conditioning programs and methodologies for scheduling and resource management. Modeling techniques, such as DES and Linear Programming (LP), were explored to find the best approach for this specific problem. Studies on coaching in collegiate and professional sports emphasized the impact of direct supervision, reinforcing the need to determine the ideal coach-to-student ratio for maximizing training effectiveness and injury prevention. Interviews with former Army Assistant Strength Coach and current Central Michigan Head Strength Coach Jake Riedal and a literature review revealed that the optimum number of coaches is viewed differently; however, the target goal would be a coach-to-student ratio of 1:20 (Fisher et al., 2021; J. Reidal, personal communication, November 18, 2024). Additionally, military-specific training programs, like Holistic Health and Fitness (H2F), highlighted the importance of a comprehensive approach, integrating strength training, cognitive resilience, and performance nutrition to enhance soldier readiness (U.S. Army, 2025). This literature review provided valuable context to how the Army, universities, and sports communities view strength and physical conditioning and identified DES as the most suitable tool to model this problem.

2.2. Stakeholder Analysis

The HP Forge facility supports at least 21 specialized courses across its three major training pipelines (SF, CA, and PSYOP), the Special Forces Warrant Officer Institute, and Noncommissioned Officer (NCO) Academy, creating a unique challenge in balancing student availability and participation and competing training requirements. Courses vary from one week to over six months in duration and have multiple class start dates each year. Opening HP Forge has increased SWCS' available training space dramatically. The HP Forge leadership is now exploring ways to better utilize the facility and its coaching staff to effectively train and support the students moving through SWCS' three training pipelines and other specialized courses (HP Forge Staff, multiple interviews, November 2024 to February 2025). The team approached this problem by first modeling and evaluating scenarios based on daily throughput and overcrowding. These two value measures were scored on a 0-100 scale, using the value functions shown in Figure 1. Daily Throughput (left graph) and Overcrowding (right graph) would be scored monthly and over the entire simulation time period. Drawing from interviews, the Daily Throughput and Overcrowding were assigned global weights of 0.6 and 0.4, respectively. This evaluation provides insight on how SWCS can better utilize HP Forge. The team then evaluated how various coaching staff levels and coach-to-student ratios impact HP Forge's ability to provide effective training to the students using the facility.

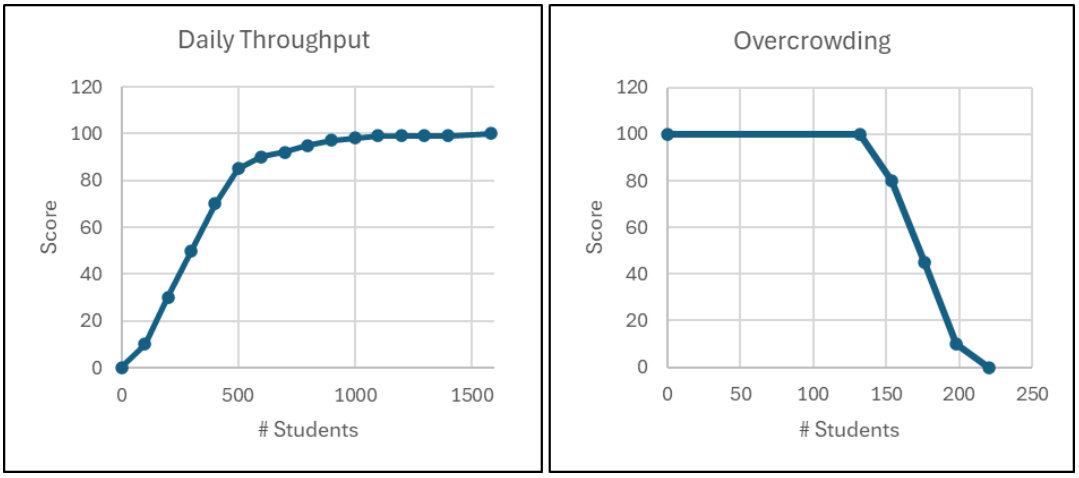

Figure 1. Value Functions for Evaluating Simulation Scenarios; Daily Throughput (left), Overcrowding (right)

3. Solution Design

3.1 Model Design

Using ProModel®, the team developed a discrete event simulation that incorporated the schedule synch matrix of over 21 special operations training courses, varying participation rates by course, scheduled 'coach-led' workout sessions, and individual gym usage (i.e., students using the facility but not as part of a scheduled 'coach-led' workout). 'Coach-led' sessions for participating courses varied from one to three sessions a week. Course information, including start/finish dates, course capacity, and student type, was retrieved from the Army Training Requirements and Resources System (ATRRS) (ATRRS, 2024). HP Forge strength coaches provided data on their scheduled workout sessions, including number of participants, types of participants, start times, and session duration. The interviews with the HP Forge coaching staff also provided information that allowed the team to estimate course participation rates and estimate individual gym use. These values became a major point of discussion as there was not sufficient data on actual participation rates and gym use to accurately model these parameters. In the end, the team used an estimated mean for these values, drawn from interviews. This information was then organized into an Excel spreadsheet which was then linked to ProModel simulation as a series of arrays. This method also allowed the team to easily adjust values when developing and evaluating the various scenarios.

3.2 Scenario Design

The team then developed three scenarios. ATRRS course information, spanning Fiscal Years (FY) 2025 – 2026, remained constant across all scenarios. The first scenario (the baseline scenario) modeled the current gym utilization, using the information provided by HP Forge staff. Scenario Two used Scenario One's input values but then added a pilot program, where approximately 33% of the students in language training attend two scheduled training sessions per week. The team developed this scenario because HP Forge noted that the language courses provide an excellent opportunity where a structured training program could deliver substantial results for students. These 4–6-month courses (depending on the assigned language) fall at the end of the SF, CA, and PYSOP qualification pipelines (HP Forge, 2025). Scenario Three increased participation rates across several courses and increased the language pilot program to 100% participation. The team's intent for Scenario Three was to dramatically increase throughput while still minimizing overcrowding and keeping within current course constraints. An example of a course constraint is that some courses have daily training schedules that do not facilitate working out in the morning. Table 1 provides a summary of the major differences between the scenarios.

Table 1. Differences between the Scenarios

	Scenario 1	**Scenario 2**	**Scenario 3**
Theme	Baseline	Pilot Program with Language Courses	Maximize Throughput without Overcrowding
Course Schedule Matrix	FY25 – FY26	-No Change-	-No Change-

Participation	• Scheduled Sessions with 11 different courses
	• Individual Gym Use, with rates & times varying by course
		• Same as Scenario 1, plus:
		  ○ Scheduled sessions with 1/3 of Language Students
			• Same as Scenario 1, plus:
			  ○ Scheduled sessions with 100% of Language Students
			  ○ Increased participation rates for original 11 courses and 5 other courses

Model verification and validation relied on individual feature testing, entity tracing, and reasonable result validity reviews. The team could not directly compare simulation results to actual system performance as there was insufficient data on

current HP Forge utilization. Regular meetings with the HP Forge staff and two site visits helped the team refine input variables and distributions as best possible. HP Forge is already exploring solutions for tracking utilization, which will increase the accuracy of the model in the future.

4. Results and Conclusion

Scenario simulations ran for two fiscal years. Daily cumulative throughput was recorded for 515 weekdays (weekends were not included, as this was out of scope for the project). Gym capacity (number of students using that facility at a given time) was recorded every 15 minutes for all 515 days. From this data, average daily cumulative throughput for each month and overall throughput were calculated and scored. The team evaluated overcrowding across the 15-minute intervals and calculated monthly and overall scores for each scenario. Table 2 shows the overall weighted scoring model results. Of note, Scenario One had no overcrowding; and Scenarios Two and Three were able to increase daily throughput without any significant negative impact on overcrowding. In fact, as shown in Figure 2, when looking at the monthly overcrowding scores, Scenario Two only had three months with overcrowding; and each of these had scores over 99.9. Scenario Three had slight overcrowding each month, but monthly scores never dropped below 94 points.

Table 2. Weighted Scoring Model

Scenario	Daily Throughput	Overcrowding	Total
Scenario 1	17.54	40.00	57.54
Scenario 2	22.01	40.00	62.01
Scenario 3	44.32	39.18	83.50

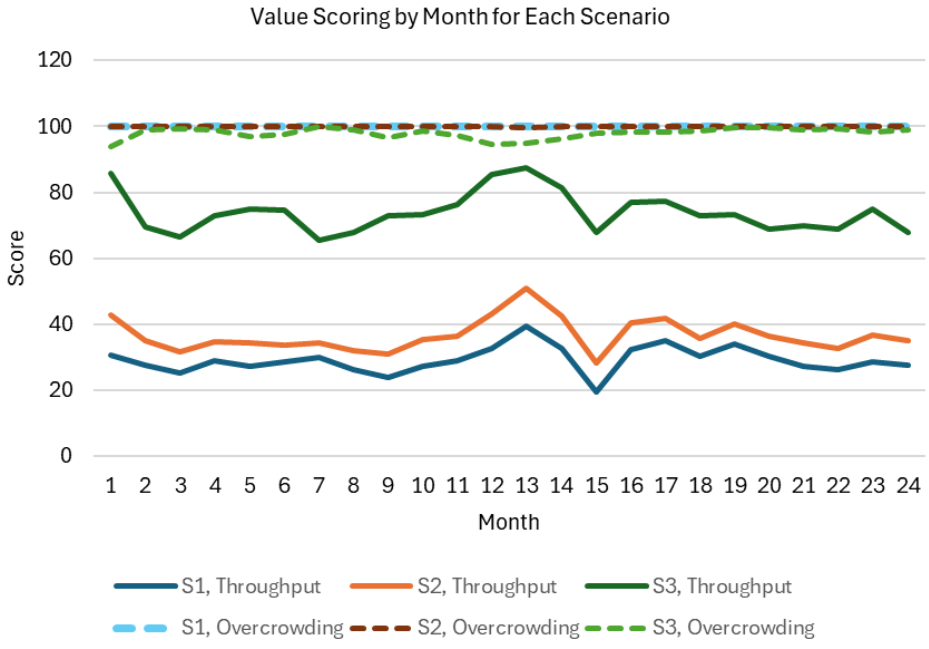

Figure 2: Monthly Scores for Each Value Measure

In assessing the impact of coaching staff levels and coach-to-student ratios, the team looked specifically at the daily peak training periods, which occur at 06:00 – 08:30 a.m. and 3:00 – 5:00 p.m. Looking at all 15-minutes periods within these

windows, across all 515 days, the team calculated the coaching coverage deficit, which is the percentage of students working out at a given time but in excess of coaching coverage capacity. The coaching coverage capacity is calculated as the number of coaches present multiplied by the coach-to-student ratio. Table 3 shows the results of these calculations. The simulation results demonstrate that HP Forge can increase facility utilization while still minimizing overcrowding and maintaining effective coach-to-student (C:S) ratios. Table 3 shows that Scenario One, which models current utilization, experiences no coach coverage deficits with as few as five coaches. This suggests that under baseline conditions, HP Forge's current staffing of six coaches is more than sufficient to manage training loads without compromising coaching quality. In Scenario Two, which introduced a pilot program for language students, coach coverage deficits remained near zero at the five and six-coach levels for all C:S ratios. To maintain a zero-coverage deficit under Scenario Two at a 1:20 C:S ratio, six coaches remain sufficient for the morning peak period, but an additional coach would be needed for the afternoon peak period.

Scenario Three, which significantly increased participation across multiple courses and fully integrated language students, revealed more dramatic impacts to coach coverage. At current staffing levels (six coaches), coverage deficits emerge at the 1:25 and 1:20 C:S ratios during both morning and afternoon peak periods, with an afternoon peak period deficit reaching 17.3%. If SWCS wishes to keep coach coverage deficits below 5%, then it would need to consider an additional coach for the morning peak period and two additional coaches for the afternoon peak period. This ensures that strength coaches are not overwhelmed, and that instruction quality remains high.

Table 3: Coach Coverage Deficit during Peak Training Periods.

	Scenario 1						Scenario 2						Scenario 3					
	AM Peak Period			PM Peak Period			AM Peak Period			PM Peak Period			AM Peak Period			PM Peak Period		
	C:S Ratio			C:S Ratio			C:S Ratio			C:S Ratio			C:S Ratio			C:S Ratio		
# Coaches	1:30	1:25	1:20	1:30	1:25	1:20	1:30	1:25	1:20	1:30	1:25	1:20	1:30	1:25	1:20	1:30	1:25	1:20
8	-	-	-	-	-	-	-	-	-	-	-	-	0.1%	0.6%	2.1%	-	0.9%	4.9%
7	-	-	-	-	-	-	-	-	-	-	-	-	0.4%	1.4%	3.3%	0.5%	2.7%	9.8%
6	-	-	-	-	-	-	-	-	-	-	-	0.3%	1.2%	2.6%	5.5%	2.2%	7.0%	17.3%
5	-	-	-	-	-	-	-	-	0.2%	-	0.2%	1.3%	2.6%	4.8%	9.3%	7.0%	15.2%	26.2%
4	-	-	1.1%	-	-	-	-	0.2%	1.2%	0.3%	1.3%	4.1%	5.5%	9.3%	14.8%	17.3%	26.2%	36.1%

"C: S Ratio" = Coach:Student Ratio
Deficits of 0.0% are shown as blank cells

5. Future Work

This research reinforces HP Forge's ongoing efforts to establish a system to track facility utilization. Collecting data on which students and courses are using the gym, frequency and time of use, and type of use (structured 'coach-led' sessions or individual workouts) would improve the simulation model. This, in turn, would give SWCS a better understanding of how facilities are being used and where opportunities exist to improve utilization and provide more effective training. Additionally, combining this tracking system with existing, or potentially new, periodic physical assessments may offer insights into training effectiveness as students' progress through their respective training pipelines.

If SWCS wishes to increase the use of HP Forge across its courses, then future research should focus on analyzing the training schedules for each of its courses. This analysis would help determine where select schedule shifts could result in a more balanced distribution of gym use throughout the day. For example, if several courses have a 9:00 a.m. – 4:00 p.m. daily schedule, shifting a few courses to 7:00 a.m. – 2:00 p.m. would promote more afternoon gym use and reduce overcrowding in the morning. It may even be possible to increase midday gym use. Ultimately, more balanced gym-use patterns will help increase daily throughput, while minimizing overcrowding. The analysis could also help identify which courses should have priority for scheduled 'coach-led' sessions. When combined with utilization goals and desired coach coverage levels, this analysis will help SWCS build and maintain an effective coaching staff.

Finally, this model can be improved by incorporating the other roles and responsibilities of HP Forge's coaching staff. 'Coach utilization' includes more than just leading strength training and conditioning sessions. A more accurate model should incorporate other key coaching functions like workout program development and workout session preparation.

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