Proceedings of the Annual General Donald R. Keith Memorial Conference
West Point, New York, USA
May 2, 2024
A Regional Conference of the Society for Industrial and Systems Engineering

Optimizing Vehicle Operations at West Point

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Abstract: Due to the decreasing amount and distribution of spectator parking spaces available for Army football games, the Army West Point Athletic Department (AWPAD) is continually faced with several traffic flow and parking challenges that are detrimental to the overall spectator experience. The goal of this research is to provide a viable long-term solution to optimize traffic flow through West Point entry gates and parking that will improve the spectator experience. Employing the Systems Decisions Process (SDP), a detailed analysis of the problem was conducted, and a long-term solution was proposed. Key findings include decreasing confusion while enhancing navigation, consolidating parking, developing a clearer understanding of worker responsibilities, and implementing robust security to mitigate risk. Based on these findings, candidate solutions were devised with the most valuable solution implementing six new parking facilities, increasing gate check station processes for post entrances, increasing security personnel, and increasing signage throughout the installation. The proposed solution effectively improves the flow of the three entrance gates while preserving maximum security and reducing confusion for spectators with the new parking structures close to the stadium.

Keywords: Venue operations, parking logistics, Systems Decision Process, sporting events

1. Introduction

Large venues, such as the United States Military Academy's Michie Stadium, attract huge spectators for various sporting events. Ensuring the safety and security of attendees and participants is crucial while maintaining the smooth functioning of operations and enhancing spectator experience and satisfaction. One of the major concerns for large sporting events is parking operations. The challenge lies in efficiently getting fans through the security screen of a military installation, to their parking lots, and then to Michie Stadium to observe the sporting event. This project analyzes how to enhance the fan experience and optimize gameday parking operations during Army football games. The project faced several limitations, including limited exposure to the AWPAD home game operations and a lack of historical data for identifying bottlenecks within the system. This project's scope is to find solutions that will help improve the fan experience by optimizing all facets of the gameday parking operations processes. The Systems Decision Process was used as a construct to assess, analyze, and develop a solution to the game day parking challenges. The goal is to increase efficiency and effectiveness in parking operations and improve the Army football spectator experience.

2. Background

It is important to understand that although sporting events' primary goal is to deliver the product of a game to a consumer, oftentimes they serve ulterior purposes such as economic, political, or reputational gain for the city or surrounding area (Taylor & Toohey, 2011). Sporting events, with their large gatherings of attendees and participants, present logistical challenges that extend beyond the field or stadium. Popular [events] like football and soccer games generate substantial vehicular congestion before, during, and after the event (Olabarrieta & Lana, 2020). Effective vehicle control emerges as a critical solution to managing traffic flow and ensuring the safety and security of all involved during gameday. Successful traffic management strategies involve distributing traffic across the entire road network, utilizing public transportation services, and implementing pre-event publicity to guide attendees (Priorities, 2023). In addition to these strategies, sufficient parking facilities prove a viable solution to vehicle control. Well-managed parking facilities ensure efficient accommodation of vehicles, reducing the likelihood of congestion and delays near the event venue (Xiao, 2019). In addition to the measures mentioned above, technology can also aid in managing traffic flow. For instance, "real-time traffic updates and dynamic routing can help spectators avoid congested areas and find alternative routes to the venue" (Xiao, 2019). Mobile apps and digital signage can also provide attendees with up-to-date information about parking availability and public transportation options. Without the effective infrastructure to support parking for large events, congestion becomes very difficult to manage. The US Department of Transportation categorizes congestion into events, demand fluctuations, and infrastructure-related issues (FWHA, 2020). While parking facilities reduce congestion, effective planning and use of personnel is another critical component of vehicle control. In A Landscape of Crowd-Management, the authors state that "planning is typically carried out in a team using a multidisciplinary approach that draws on the perspectives and expertise of a wide range of individuals. These include the event organizers, crowd managers, police, stewards, first-aid representatives, local authorities, transportation operators, and crowd simulation experts" (Wijermans, Conrado, van Steen, Martella, & Li, 2016). The combination of physical facilities as well as effective planning and execution by personnel ensure efficient crowd movement and safety during large venues.

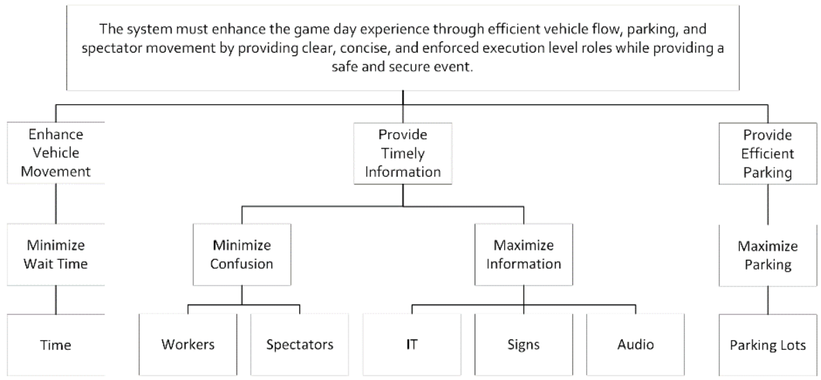
3. Methodology

To fully understand the complexities of vehicle and parking operations on gameday, the four-phased SDP model was used. This model consists of the problem definition phase, solution design phase, and decision-making phase. The final phase, implantation was not used for this analysis. After this process, a feasible solution is generated to provide the most value for key stakeholders. In the problem definition phase, the team conducted literature reviews, stakeholder and research analysis, functional analysis, and value modeling to produce a redefined problem statement. Stakeholder analysis, in the form of interviews, was conducted to gain an understanding of the stakeholder's perceived problem. Research analysis, in the form of literature reviews, was used to gain more knowledge on the historical background and current gameday vehicle operation systems. Functional analysis was then used to determine the fundamental objective that the solution needed to address. A qualitative value model was built to define objectives and value measures in this value-focused approach. Production of a systemigram was built to display the interconnectedness of each component of the system. A quantitative value model was also produced to assess the candidate solutions' alignment with the fundamental objective of the systems decision problem. This model entails identifying the fundamental objective, functions providing value, objectives, and value measures. This is followed by stakeholder engagement to score value measures and develop value functions. Following stakeholder needs assessment, the solution design phase generates a pool of candidate solutions through idea generation, alternative generation, and solution scoring. A design criterion was developed with different parameters and options constructed from a groupthink activity. Solution scoring involves assigning scores based on predetermined criteria, facilitating systematic comparison of alternatives, and covering factors like cost-effectiveness, feasibility, performance, risk, and alignment with organizational goals. Ultimately, solution scoring enables organizations to identify and prioritize suitable solutions, with the highest value score recommending the optimal solution to stakeholders.

4. Analysis

The initial problem statement addresses the complexity of efficiently managing vehicle and spectator flow during Army West Point Athletics Department (AWPAD) football games at Michie Stadium. The goal is to improve the overall fan experience, considering the challenges posed by West Point's unique location and historical fortifications. Extensive research, along with stakeholder engagement, was crucial in identifying solutions. Literature reviews explored potential threats at sporting events, emergency operations, security, and stadium operation centers. Interviews with major stakeholders, including Deputy Athletic Director Dan McCarthy and Head of Vehicle Operations Shane Bell, provided valuable insights. Game day operations were observed at Michie Stadium and MetLife Stadium, encompassing parking and vehicle operations, people flow, and security. The findings, conclusions, and recommendations, compiled into an FCR Matrix, highlight key areas for improvement: Decrease confusion and enhance navigation for spectators and workers, develop a clearer understanding of roles and responsibilities among different organizations, and implement robust security measures to mitigate risks. The fundamental objective emerged from these recommendations: "The system must enhance the game day experience through efficient vehicle flow, parking, and spectator movement by providing clear, concise, and enforced execution level roles while ensuring a safe and secure event."

A functional hierarchy and flow diagram were created to identify functions aligned with the fundamental objective. The team identified three functions: providing timely information, efficient parking, and enhanced vehicle movement. The qualitative value model broke the functions into objectives, covering areas like minimizing confusion, optimizing parking and wait times, and maximizing information. Value measures were created and defined, with acceptance from the stakeholders. To



provide timely information, the value measures were workers, spectators, IT, signs, and audio. For *provide efficient parking*, the value measure was parking lots. Lastly, for *enhancing vehicle movement*, the value measure was time.

Figure 1: Qualitative Value Model

Value measures for each objective were scored across multiple categories, ranging from 1-3 or 1-4, and integrated with stakeholder feedback to create a swing weight matrix for global weights. In Figure 1, there are seven total value measures. The value measures were used to devise the design criteria, which had five parameters: flow, signage, information technology, workers, and parking. Candidate solutions were then generated and evaluated, the stacked bar chart visible in Figure 2. The solution with the highest value, "High Tech," is selected for implementation, yielding 84.91 units of value. When conducting sensitivity analysis with the solutions, it became evident that there was no significance in sensitivity, making “High Tech” the best solution. This solution focuses on the installation of six new parking structures, increased signage using VMS trailers, the introduction of ALO.ai communication tool for worker comprehension, and the establishment of temporary gates with additional personnel, to advance to the implementation phase, surpassing the current system's zero value benchmark, with the ideal solution set at 100 units. This is the candidate solution implemented in the decision-making phase.

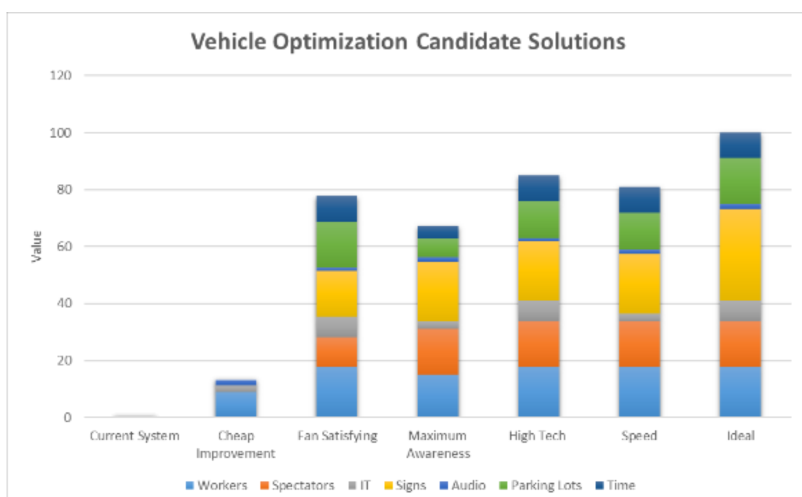


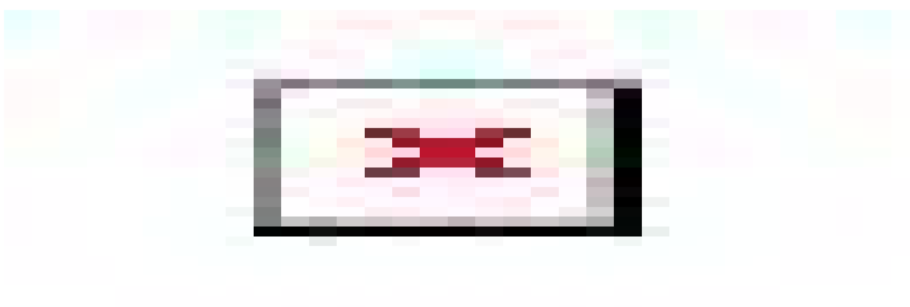
Figure 2: Candidate Solution Stacked Bar Chart

Currently, new gameday workers at West Point are not familiar with the layout of the installation and available parking lots for fans. As a result, spectators themselves often struggle to navigate the area. To address these issues, ALO.ai software has been proposed to assist workers with task delegation and translation, while Text-Em-All software is being considered as a means of distributing important updates and information to spectators via SMS messaging.

The current signage system is confusing as the arrows referencing where to go for fans are placed at major intersections and only utilize arrow signage to illustrate to fans where to go. The proposed plan to fix this is to first build digital kiosks in strategic locations such as Trophy Point, Eisenhower Hall, and at the intersection of the Supes House and Beat Navy Tunnel. All these digital kiosks will serve as maps for the spectators to help guide them toward the stadium. Additionally, variable message systems will be utilized across the campus to guide spectators in vehicles toward the lots. Though the variable message systems are effective they will only be utilized at the entrance of lots and along the routes specifically in intersections. Along the routes, Wire-H stakes with signs on top of them will be placed to guide spectators towards the lots. The additional signage proposed will ensure that fan confusion is minimized.

The current parking system utilizes each parking lot and flat surface to house vehicles for sporting events, as shown in Figure 3. This system causes detrimental damage to the grass fields, confusion to first-time spectators, and chaos to the residents of the West Point installation. All these parking lots and fields add up to approximately 8,400 parking spots. The optimal candidate solution integrates six new parking structures within a half-mile radius of Michie Stadium. These new facilities would reduce the need for shuttle buses, as more attendees could park closer to the stadium. Additionally, the construction of new parking structures would eliminate the need for fans to park on grass fields. The new parking structures stated earlier would be where the current E Lot, F Lot, C Lot, A Lot, K Lot, and Delafield Pond are, as shown in Figure 4. To not eliminate the possibility of tailgating, each parking structure would have an outdoor park attached to facilitate tailgating activities. To build a parking garage, allocating a minimum of 300 square feet per car is necessary. For instance, a one-level parking garage accommodating 300 cars will require *90,000 square feet* of space. Following an analysis of the projected dimensions of the proposed parking garages, Table 1 depicts the new amount of parking spaces that would add to 10,460 total spots.

Table 1: Parking Structure Analysis



Shuttle services during Army football games can also be quite challenging, but a proposed shuttle bus route aims to overcome this obstacle. By implementing this new singular route, the number of required busses can be reduced while still allowing spectators to enjoy parades on the Plain. Instead of 30 shuttles assigned to three different routes, which leads to overlap and congestion, as shown in Figure 5, the new singular route would only require 10 shuttles, depicted in Figure 6.

Figure 3: Current Parking System

Figure 4: Revised Parking System

Figure 5: Current Shuttle Routes

Figure 6: Revised Shuttle Route

ISBN: 97819384962-4-0

Increasing the number of gate guards at each gate will significantly enhance the efficiency of vehicle flow through the checkpoint. With the implementation of rigorous ID/pass checks for every vehicle and the use of inspection mirrors by guards stationed on the opposite side of the vehicle to scrutinize its underside, thorough security measures will be ensured. While one guard verifies identification documents, the other guard conducts a comprehensive check around the vehicle, ensuring no security threats are overlooked. Upon inspection completion, the gate guards will signal to their counterparts in their lane, indicating readiness to proceed. Only after all vehicles are deemed secure and ready will they be sent through in groups, streamlining the flow and maintaining the integrity of the security protocol. In Figure 7, the new system for gate guards is visible.

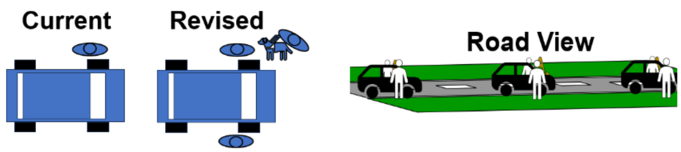


Figure 7: New Gate Security Check

5. Gate Throughput Results

To improve the throughput of the three gates onto the post (Thayer Gate, Washington Gate, and Stony Lonesome Gate) simulations were conducted in ProModel to analyze both the current operations and proposed improvements. ProModel allows for the input of interarrival rates, processing times, and capacity of locations that generate data on total throughput, waiting and blocked times, and average time in the system for the vehicles arriving to post. Due to a lack of data from the stakeholders, assumptions had to be made regarding each gate's interarrival rate and processing times. To show the improvement of the system, a deterministic interarrival rate of 0.12 minutes/car was assumed, and a processing rate of one minute with a standard deviation of 30 seconds over a normal distribution was assumed for the inspection of each car. The original system contained one or two inspection stations depending on the gate, as can be seen below. The original system is visible in Figures 8-10.

Figure 8: Stony Lonesome Gate Original

Figure 9: Washington Gate Original

Figure 10: Thayer Gate Original

The proposed solution is visible in Figures 11-13. Each gate has two lanes of inflow traffic, with three inspection stations set in each lane. Cars will be processed in groups of three to ensure communication and inspections are done to standard before being allowed onto the post. Washington Gate will be an inflow-only gate before kickoff to allow for two lanes to be utilized.

ISBN: 97819384962-4-0

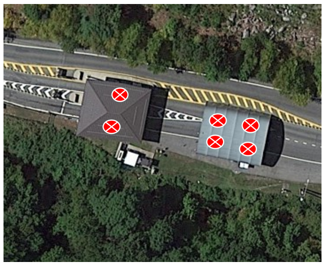


Figure 11: Stony Lonesome Gate Revised

Figure 12: Washington Gate Revised

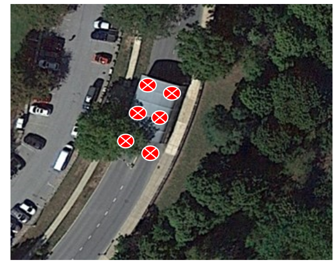
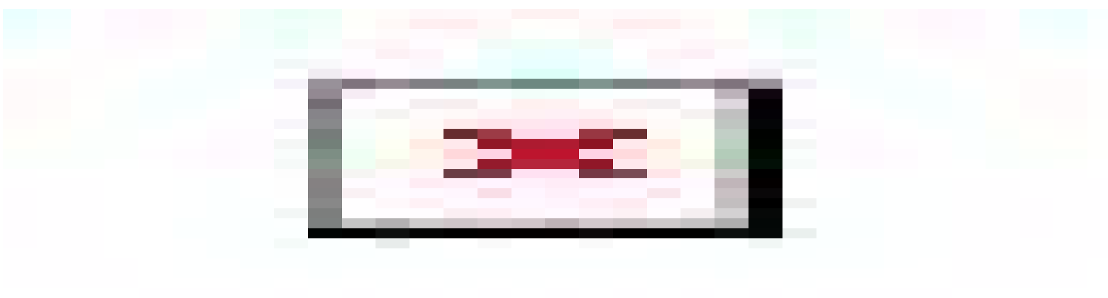


Figure 13: Thayer Gate Revised

The results yielded significant improvements compared to the original system. Table 2 shows the average improvements of the system for all three gates.

Table 2. Improvements to the Gate Entrance System



The improvements made to the system prove to be vital in the effective processing of cars through the gates and onto the post. Additionally, security risks will be minimized as free flow (eliminating security checks and allowing all cars with a game ticket to pass through) will not be utilized for gameday operations.

6. Conclusion

Specific to vehicle operations at West Point, effective communication and efficient movement are key to minimizing waiting time, maximizing security, and enhancing the fan experience. Following conclusions from research and development of capstone deliverables, enhanced training for vehicle operations personnel, implementation of modern technologies for purposes of communication to fans, and an overall emphasis on shared understanding between AWPAD and the fans are the most significant factors that enhance satisfaction for the gameday experience. While the current vehicle operations plan set in place works very well, there is a way to make it more effective by finding ways to push information out to fans so that everyone who attends gameday knows which gate to come in, where to drive and park, and how/where to enter Michie Stadium. In doing so, more people can get into the stadium quicker as well as minimize the distance they must walk to get to Michie. A reduction of backup and traffic outside of the gates can be done which will maximize the safety and satisfaction of fans while attending Army football home games. The solution presented in this article was modeled and simulated using ProModel. More in-depth analysis and details of this project can be found in the Technical Report formulated by this capstone team.

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