

Equipment Turn-In and Transfer Process Modeling

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Abstract: In military bases across the country, there is excess equipment that costs money to store while it is going unused. When this excess grows large enough, there is an obvious need to turn it in or transfer it to a location where it will be used, but there is not currently a process in the military to handle large stocks like Fort Hood, Texas. This research examines the possibilities of what this turn-in process can look like and how to create a modernized and synchronized method that can be employed across the Army. Modeling this proposed process in ProModel should highlight issues with the current flow and recommend system improvements. Although the process has just been implemented at Fort Hood, there are several system improvements that have been identified by backlogs in the discrete-event simulation including reducing process times, allowing workers to perform tasks in parallel, and reducing time needed to order and install parts. These improvements will make the equipment turn-in process more manageable for Army-wide implementation and success.

Keywords: Equipment Turn-In, Discrete-Event Simulation

1. Introduction

Within the United States Army, the 13th Expeditionary Sustainment Command (ESC) oversees all sustainment and distribution operations for units stationed in the western portion of the United States, including III Corps. III Corps includes the 1st Infantry Division, 1st Armored Division, 1st Cavalry Division, and numerous support units. It currently has over 42,000 pieces of equipment that needs to be turned-in for either disposal or transfer to other units. Fort Hood, Texas has been designated as the III Corps consolidation location where the turn-in process is set to occur. The first phase of this turn-in was scheduled to occur between November 2020 and March 2021. The 407th Army Field Support Brigade (AFSB) is the unit under the 13th ESC that has been tasked with overseeing this turn-in operation.

This study sets out to model and analyze the overall efficiency of the operation to support the 13th ESC and the 407th AFSB improve the equipment turn-in process for III Corps. This analysis started with an in-depth stakeholder analysis, data collection, and research into the current processes. This information allowed for the creation of a discrete-event simulation of the turn-in process, allowing for the identification of capability gaps and opportunities for optimization. This paper discusses the steps of building the model and analysis of improvements to the system that will allow it to be widely implemented across the Army.

2. Background

2.1 Problem Introduction

Equipment turn-in is a process that is often overlooked in the Army due to the perception that excess equipment will not effect the overall readiness of a unit or their likelihood to complete a mission. However, storing unused equipment removes resources, including funding and maintenance, that could be used for ensuring that troops are getting the proper new equipment and training that they need to be successful in their mission. Therefore, as the Army has been modernizing and rapidly gaining new equipment over the past twenty years, this outdated and unused equipment has been piling up and creating one of the largest equipment backups than the Army has ever seen. Thus, the current procedure that is meant to handle small numbers of equipment cannot keep up with the modernization and acquisition efforts across the Army. A new method is needed to efficiently hold and process a larger amount of equipment than has ever been seen (Department of the Army [DA], 2016).

The most recent comparison to the current process was done by the 1st Air Calvary Brigade (1 ACB) in July 2020 and was known as “Operation Pegasus Harvest.” This operation only looked at the turn-in of a limited number of excess pieces of equipment but created a framework to build upon and use as a reference. According to this operation, the large amounts of excess equipment cause issues with supply availability, supply chain efficiencies, and supply chain velocity (Torres, 2020). This operation transitioned an unused motor pool into an operations headquarters where logisticians and the sustainment brigades would solely focus on turning in equipment. This focus on a singular mission enables the turn-in to occur all at once and allows the units to drop off their equipment quickly so they can focus on modernization rather than navigating a complex turn-in process. Operation Pegasus Harvest laid the framework for the future of bulk turn-in for III Corps and potentially the Army and the concept of having large consolidation points for streamlined turn-in.

Some key recommendations gained from this project include planning out specific staffing requirements beforehand, streamlining the maintenance operation stage, and increasing the pace of the Proposed Sourcing Decisions (PSD) (Dennis, 2020). PSDs help keep track of equipment inflow and outflow as well as approve movement and ensure that the excess equipment is replaced. Ensuring that the staff has access to and is competent in Global Combat Support System – Army (GCCS-A) is a key requirement to ensuring that the entire turn-in process flows well. GCCS-A is an online database to help organize property management, supply operations, maintenance, and logistical support. For the maintenance operations phase, having the proper maintenance equipment on-site beforehand is one suggestion that ensures timely repairs to keep the process moving. Finally, the slow speed of the PSDs is a stage that all equipment requires and was an inefficiency during Operation Pegasus Harvest.

2.2 Discrete Event Simulation

Discrete event simulation (DES) is commonly used for analyzing and optimizing many manufacturing and service-based problems because of the ease of modeling processes (McCarthy & Razon, 2021). DES has been further used for a range of military applications including modeling the officer accession process, analyzing mobilization procedures, and optimizing the flow of soldiers through a physical fitness test (McCarthy et al, 2021).

Unique components of DES that make them applicable to modeling the equipment turn-in process include having distinct entities moving in the system, state changes occur at discrete points of time, the system can be viewed as a network of activities and lines, and activity durations can be estimated and analyzed using statistics (McCarthy et al, 2021). In the equipment turn-in process, the entities moving through the system are distinct pieces of equipment with unique traits and process requirements. Additionally, the state changes of these entities occur at set points within the path of movement. The equipment turn-in process is modeled as a combination of several activities in a set order with wait times and holding areas depending on the flow of other units through the system. Finally, the durations for the activities in the equipment turn-in process can be estimated from previous data and experience but are also able to contain stochasticity based on the uncertainty associated with the activities.

3. Process Overview

3.1 Observations of Current Process Plan

With no doctrinal answer to this problem, leaders at the 13th ESC have developed a process plan that is being implemented as a guide for the initial stages of large-scale turn-in. This process places the equipment into categories based on the destination of the equipment. There are five possible locations as represented by the categories in Figure 1 including:

- Defense Logistics Agency Directive (DLAD-S): disposes of equipment no longer required.
- Depot: transfers equipment to a more consolidated supply point for issue and storage.
- Inter-Army Command (ACOM): transfers equipment to a different ACOM based on location.
- Intra-ACOM: transfers the equipment within the same ACOM.
- Intra-Post: transfers equipment within the same Army post.

At each of these locations, there are different steps and paths that the equipment follows until it makes it to the destination or output location.

In addition to being split up by location, the equipment is also categorized by type. The four broad equipment types that are used include rolling stock, non-rolling stock, hazardous material (HAZMAT), and classified. Rolling stock includes vehicles, HAZMAT equipment includes equipment with dangerous materials or substances, classified equipment includes any decoding materials, and non-rolling stock is all other equipment that does not fall into one of the other categories. Each of these categories has unique process steps within each of the buckets, so differentiating them helps to ensure that all of the equipment follows the necessary steps to complete turn-in. In Figure 1 below, the different categories are shown with the green and orange

arrows representing administrative work that is required but occurs in parallel, while the blue arrow represents the delivery procedure required for the equipment. The processes along the orange arrows represent steps that are required with vehicles and no other types of equipment. Within these arrows, smaller activities are represented with labels to show necessary subroutines within the activity.

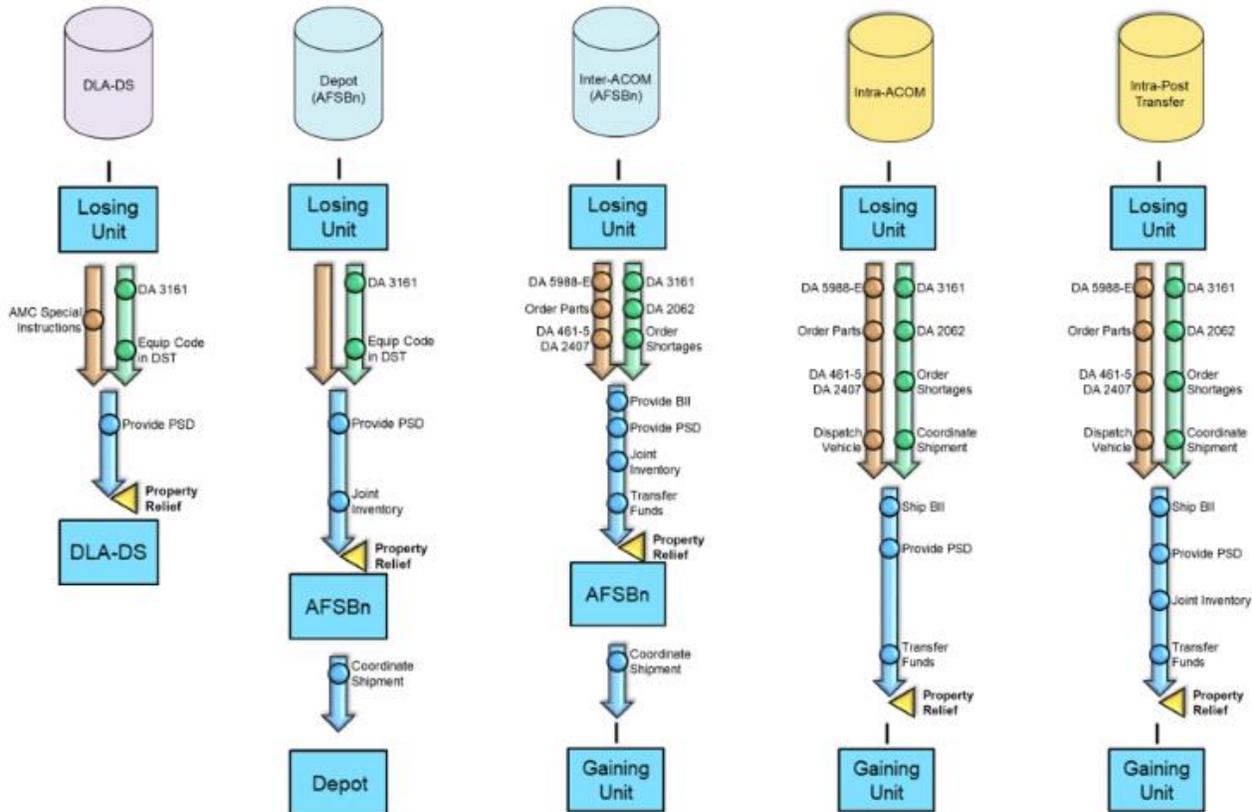


Figure 1. Transfer/Turn-In Process Overview

3.2 Possible Opportunities for Improvement

Throughout conversations with stakeholders and additional observations gained from Operation Pegasus Harvest and the beginnings of the III Corps turn-in, there are several areas where the process is observed to have queues develop. These areas include the PSD process and the process of ordering and awaiting parts.

The current PSD process is scheduled to take up to 1,100 hours to complete per piece of rolling stock and 96 hours per piece of the other types of equipment. Additionally, it can only be done by one person per turn-in site. If this process can be streamlined in a way that allows multiple workers to collaborate at once, it could provide velocity in this area that seems to hold up the progression.

The next area that is anticipated to hold up the process is the time awaiting parts. Even though this step is only for equipment that requires parts to be received from other locations (which is mainly rolling stock), it takes a minimum of 28 days for these shipments to arrive to the consolidation point. Thus, this step holds up the processes significantly and takes up space at the consolidation point that inhibits more equipment from coming in. A separate holding area for this equipment that needs parts is one possible way to free up space to decrease wait times and improve efficiency.

4. Model Development

Since the processes outlined in Figure 1 all have variability involved in them and are not identical for every piece of equipment, a discrete event simulation is most applicable to model the process. In addition, the added variability that can be implemented into the model will develop useful insight for the analysis of the equipment turn-in problem. Using a simulation software called ProModel, a simulation can be constructed and then replicated to conduct analysis. The model shows efficiencies and bottlenecks in the process and highlights areas that can be improved to decrease the amount of time that equipment turn-in takes. Simulation also enables researchers to modify inputs or adjust the process and compare results to the status-quo.

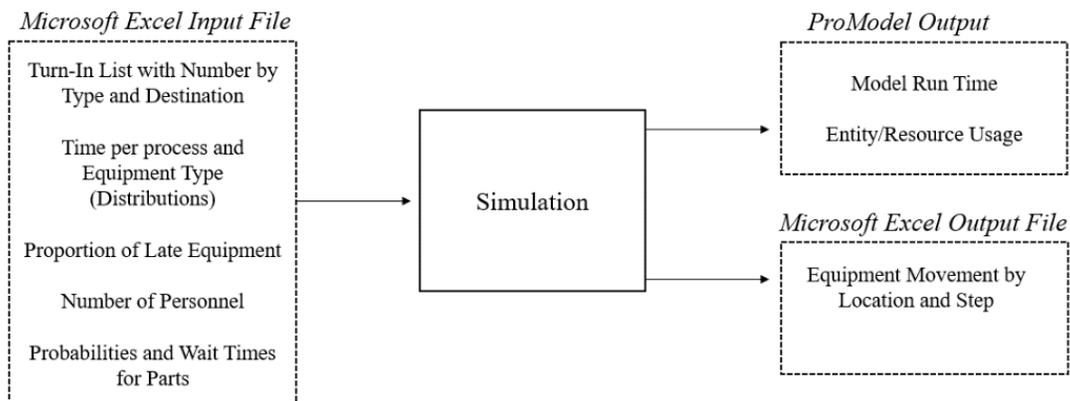
4.1 Model Overview

A broad overview of the system architecture beginning with the Microsoft Excel input file and ending with the ProModel simulation and Microsoft Excel output file is shown in Figure 2. The information from the input file is coded into the ProModel file so the system data can be updated and used in the model. In addition to the Excel file feeding into the simulation, the file can also be easily accessed and edited by the client to allow for real-time updating of times as new data is collected. As shown in Figure 2, the input file is divided into four tabs with separate input information. The first tab includes an array that separates the total number of pieces requiring turn-in into the different types and destination locations. The second tab has uniform distributions that includes process type by equipment type. The third tab has an array with the proportions of equipment requiring parts by type and the wait time for these pieces. Finally, the fourth tab contains various other inputs such as number of available supply and maintenance workers and proportion of equipment that arrives late. Section 4.2 provides more detail on where the assumptions for the input file were derived from.

Figure 3 below shows a screenshot of the simulation with the pieces of equipment moving through the various locations. The user of the model can change the number of each type of equipment and run multiple iterations of the model to determine the time for the entire turn-in process as well as the time in each of the stages. The more iterations of the data that are run, the more accurate and realistic the results of the model are in determining how long a certain unit will take to turn-in their excess equipment.

ProModel generates an output file that provides data on the total process time for all pieces of equipment to run through. However, there is a subroutine in the simulation that generates an accompanying Excel file that can be sorted and filtered to follow specific pieces of equipment through the model or different locations. This tracking provides specific information about process length and efficiency.

Figure 2. Discrete Event Model Architecture



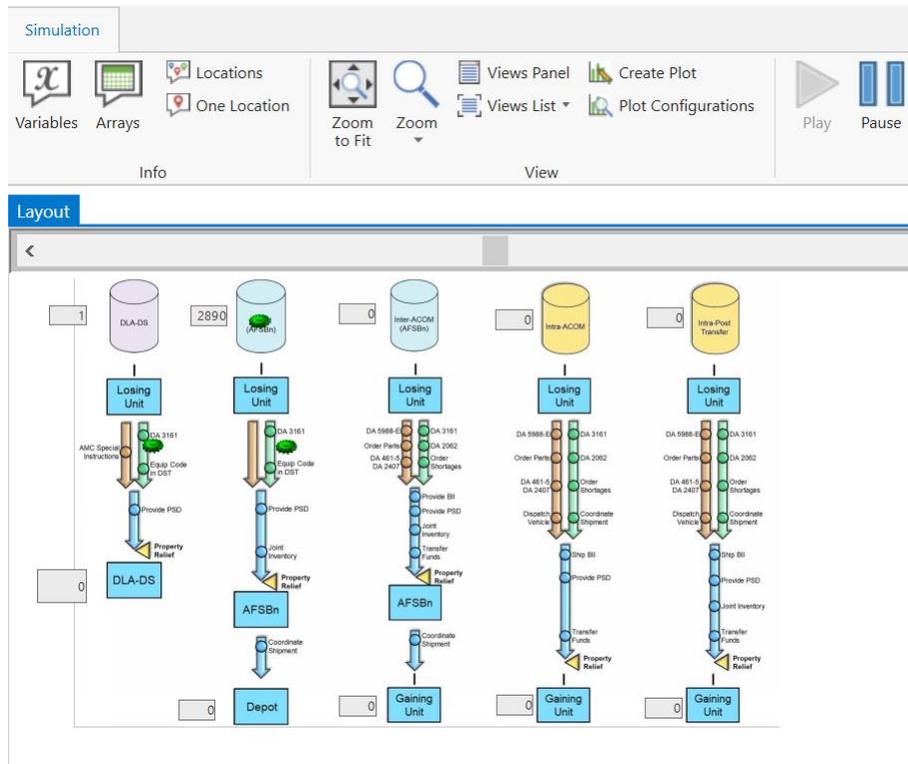


Figure 3. Screenshot of ProModel Simulation while Executing

4.2 Input Assumptions

There were several assumptions that were followed within the Excel input sheet to build the simulation. For example, to break down the equipment by type and destination, data from the 13th ESC was analyzed and proportion of each type of equipment and destination were created to estimate the percentages of the total number of each type. Using these proportions and a total number of equipment, the numbers of each type are generated in an array that is shown in Table 1.

Table 1. Equipment Type and Destination Breakdown

Type	% of Type	DLADS	Depot	Inter-ACom	Intra-ACom	Intra-Post
Rolling Stock	0.077	1440	207	687	379	383
Normal Stock	0.902	2413	2413	8008	4424	4461
HAZMAT	0.019	50	50	165	91	92
Sensitive	0.002	5	5	16	9	9

% of Equipment	0.465	0.067	0.222	0.123	0.124
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Another assumption regarding process times was made to the input file. Table 2 shows each available step and the times (in hours) associated with the completion of each. These are broken down by equipment type as each type is assumed to have similar process times. There is also a mean and half-range associated with each to provide ProModel with a uniform distribution of time. Stakeholders from the 13th ESC provided initial estimates for the time processes associated with each process. However, these estimates can be updated as more real-world data becomes available.

Table 2. Process Time Input Array

Process	Category	Rolling Stock			NonRolling Stock			Hazmat			Classified		
		Quantity	Time		Quantity	Time		Quantity	Time		Quantity	Time	
			Mean	HalfRange		Mean	HalfRange		Mean	HalfRange		Mean	HalfRange
DA 3161	Supply	2	0.5	0.25	1	0.5	0.25	1	0.5	0.25	1	0.5	0.25
DA 1348	Supply	2	0.5	0.25	1	0.5	0.25	1	0.5	0.25	1	0.5	0.25
DA 5988-E	Maintenance	2	0.5	0.25	1	0.5	0.25	1	0.5	0.25	1	0.5	0.25
DA 461-5	Supply	2	0.5	0.25	1	0.5	0.25	1	0.5	0.25	1	0.5	0.25
DA 2407	Supply	2	0.5	0.25	1	0.5	0.25	1	0.5	0.25	1	0.5	0.25
Order Parts	Maintenance	2	1	0.5	1	1	0.5	1	1	0.5	1	1	0.5
Dispatch	Maintenance	2	0.5	0.25	0	0	0	0	0	0	0	0	0
Order Shortages	Supply	2	1	0.5	1	1	0.5	1	1	0.5	1	1	0.5
Shipment	Maintenance	2	4	2	1	1	0.5	1	1	0.5	1	1	0.5
AMC Instructions	Supply	2	1	0.5	1	1	0.5	1	1	0.5	1	1	0.5
Equip Code	Supply	2	1	0.5	1	1	0.5	1	1	0.5	1	1	0.5
Provide PSD	Maintenance	2	1100	550	1	96	48	1	96	48	1	96	48
Joint Inventory	Supply	2	2.5	1.25	1	1	0.5	1	1	0.5	1	1	0.5
Provide Bill	Supply	2	1	0.5	1	1	0.5	1	1	0.5	1	1	0.5
Transfer Funds	Supply	2	1	0.5	1	1	0.5	1	1	0.5	1	1	0.5
SF 700	Supply	0	0	0	0	0	0	1	1	0.5	0	0	0
Zero Memo	Supply	0	0	0	0	0	0	0	0	0	1	1	0.5

4.3 Model Process Flow

The model consists of the same locations for each of the five destinations: Arrival, admin, delivery, and termination as illustrated in Figure 4 below. In each of these locations, the equipment is routed through various subroutines that correspond to the required tasks. The entities that flow through the system are the four types of equipment: Rolling stock, non-rolling stock, HAZMAT, and classified. These types are visually separated in the model by using different graphics. A representation of this is shown in Figure 3.

All equipment arrives to an origin point in the model. When space is available in each of the destination processes, the equipment is separated based on the percentages from the input file. Next, the equipment is routed through each of the locations and subroutines until it reaches the end point and departs the system. The only exception to this flow is if a piece of equipment requires a part that needs to be shipped from another location. If this is the case, the equipment is routed to the awaiting parts holding area until the parts are received, and it is sent back to normal process movement. Additionally, there is a process built into the model that allows the steps happening in the admin phase orange and green arrows (orange and green arrows in Figure 1) to occur simultaneously.

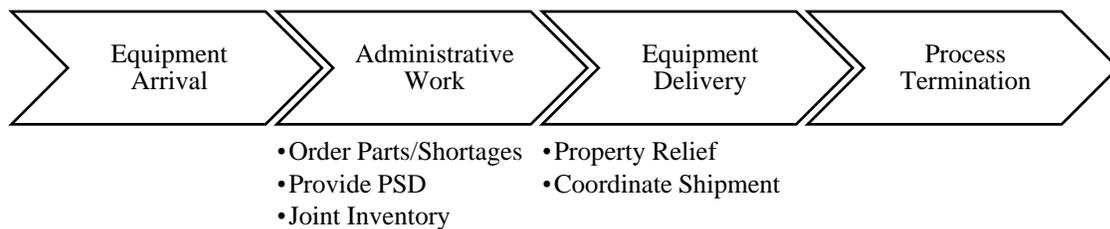


Figure 4. Model Process Flow

5. Results and Analysis

5.1 Verification and Validation

Verification and validation ensures the dependability and usefulness of a model. Verification is the process of ensuring the model meets the specifications and runs correctly. Validation is the process of ensuring the model addresses a real-world need (Law, 2015). While building the ProModel simulation, verification was done by using an iterative model that built in more complexity as the simulation was being constructed. This incremental process helped to debug and ensure that the model was performing all necessary functions correctly. To validate the model, client meetings were held to discuss the progress of the model. Each time they were briefed on the requirements of the model, the code in ProModel, and the functioning simulation. Their additional data and inputs helped ensure the numbers going into the model were accurate.

5.2 Process Times

After running the simulation with the distribution of parts as listed in Table 1, the time to run all pieces of equipment through the turn-in process was 155,496 hours. This number is extremely large and makes it seem as though the equipment that is currently awaiting turn-in may never complete the process. However, there are improvements that can be made to the system that drastically reduce wait times for equipment and streamline the turn-in process.

For example, the largest time for an individual subroutine in the model is 1,100 hours to provide PSDs for the equipment. This process has a long time associated with it due to the nature of the task being in a data base. Thus, only one supply person can work on the parts at a time. Because only one supply person can work on this task at a time, the system becomes extremely backlogged and all other pieces of equipment are slowed down at this point. By cutting the PSD time in half to 500 hours, the process times are reduced to 88,577 hours.

Another backlog in the original results relating to the PSD process time is the number of each type of worker. Since there are maintenance workers and supply workers that work on different processes, there were times when some of each type were idle during the simulation. Accordingly, by doubling the number of each type of worker from 45 to 90 and allowing them to work on different processes when available, the time to process this equipment through the system reduced again to 39,895 hours.

5.3 Recommendations

Although the current process results in turn-in times that are large and unmanageable, there are several known improvements that can cut down the total process time for equipment turn-in. Reducing each individual process time is one step that will cut down overall process time. Providing PSDs accounts for 98% of overall time in the system for rolling stock and 90% for the other equipment types. Therefore reducing the time it takes to complete this task is top priority. To do this, 13th ESC could allow simultaneous access to online systems by workers; however, many of the other processes including AMC instructions and equipment code are also performed on computers with limited parallel work allowed.

In addition to working on computer programs concurrently, another improvement that is possible is allowing maintenance workers to work on supply tasks and supply workers to work on maintenance tasks. This modification would allow workers to fill in spots where backlogs occur and make idle time regarding equipment and workers much smaller.

Finally, another improvement that can be made to the system is providing a more streamlined system for ordering and receiving new parts. Currently, if a piece of equipment requires parts before turn-in, ordering parts and receiving them at the turn-in site takes upwards of three weeks. This delays all subsequent actions in the turn-in process, increases total times, and decreases the space at the turn-in site to move other equipment through. Having frequently needed parts available at the site or in the area is one way to reduce this wait time and move all equipment more smoothly through the process. Figure 5 shows a graph of these model versions and their total output time decreasing as improvements were reflected in ProModel. Version 1 of the model has the original process times and number of workers, Version 2 has PSD process times at 500 hours, and Version 3 has the number for both supply and maintenance workers set to 90. Process time reductions by this large of a number are reasonable for the equipment turn-in process due to the variability of the time that each task takes and the possibility of combining tasks.

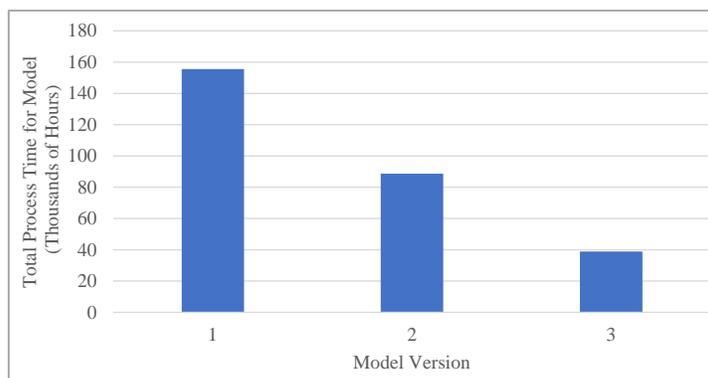


Figure 5. Total Process Time Improvements

6. Conclusion

Backlogs of excess equipment is becoming an increasingly relevant topic at the highest echelons of the Army due to the increased demand for acquisitions and integrating new technology into units. The buildup of older equipment not only takes up physical space that these units could potentially use to store more updated technology, but also takes funding and resources such as maintenance away from more modern equipment. Along with the modernization of equipment, the Army needs to develop a more updated turn-in and transfer process for this large amount of equipment. The 13th ESC and III Corps is currently piloting a new equipment turn-in process in Fort Hood, Texas. Using a discrete event simulation created in ProModel, this proposed process can be analyzed based on data that can be updated as the effort continues. Areas for improvement have already been identified including making the PSD process more user-friendly and efficient and increasing the velocity of ordering and receiving parts for equipment that needs updates.

6. References

- Dennis, M J. (2020). *Pegasus Harvest Lessons Learned*. Fort Hood, Texas: 1CDSB.
- Department of the Army. (2016). *Inventory Management: Using Unit Supply System (PAM 710-2)*.
- Law, A. M. (2015). *Simulation Modeling and Analysis*. New York: McGraw-Hill.
- McCarthy, S., & Razon, C. (2021). *Modeling Human Processing Systems in Discrete Event Simulation*. Proceedings of the **Error! Reference source not found.** Winter Simulation Conference.
- Torres, A. (2020). *A Shock to the System: How 1CDSB Turns Excess to Readiness*. Washington, D.C.: U.S. Army.