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| George Mason UniversityGMU_PLogo_RGB |
| **Production Cost Savingsat *Washington Post******Executive Summary*** |
| Team Power WashPost |
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# 1 EXECUTIVE SUMMARY

## 1.1 FOLLOW-ON STUDY OF PREVIOUS GROUP

In August 2010, a team of George Mason University (GMU) students, known as “I’m Pro WashPost”, from the Volgenau School of Engineering performed a research study to identify potential production cost savings for the Shipping and Receiving Department at the *Washington Post* plant in Springfield, Virginia. Their study focused on the material handling and labor processes within the plant. The team collected data on the routes and the labor force used during a one-week period to use in their analysis.

Their goal was to determine material handling routes and labor assignments that would allow the *Post* to move the required materials using a minimum number of resources. In this case, the minimum number of fork truck and deep reach fork truck drivers.

## 1.2 WHAT THEY DID

They gathered data for material movements from the Material Tracking and Control (MTC) system that the *Post* uses to schedule and track pallet moves within the plant. The *Post* also provided the workforce breakdown by Day/Shift/Location. The team documented all routes used during a one-week period and collected route times for each pallet move.

## 1.3 THEIR RECOMMENDATIONS

They conducted a process evaluation, a labor analysis, and an analysis of routes which resulted in three groups of recommendations:

* + - Labor reductions
		- Route simplifications
		- Improved data tracking

The *Post* began an incremental implementation of several recommendations in December 2010.

## 1.4 WHERE WE STARTED

A second team, known as Power Wash Post (PWP), began working with the *Post* in January 2011 with the goal of expanding the static analysis done by the previous group. This expansion provided a dynamic simulation model of the helper component of the *Post’s* four work centers. The work centers are composed of primarily two labor categories: helpers and mailers. The mailers operate the collators and inserting machines (SLS machines), while the helpers move the pallets to the various machines, staging areas, and storage racks.

## 1.5 OUR METHOD

Team PWP received a similar data set as the first team; a one-week period in February 2011. After a cleansing to remove anomalous routes, Team PWP mapped all of the remaining routes to specific helper zones within the system. Then, descriptive statistics were obtained on route times for model input to determine the best distribution and mean of the input data. From this, Team PWP determined that a significant amount of the route times received from MTC were invalid and they decided to use estimated route time data as recommended by the client instead. In addition, they collected data on markup helper schedules, arrival processes, and internal system business logic that were used to build a simulation model in Arena.

## 1.6 OUR TECHNICAL APPROACH

Based on an in-depth study of the operational process at the warehouse of the *Post* and thorough discussions with the customer, Team PWP decided the best approach was to build a discrete event simulation model in Arena platform after comparing alternative options, given the nature and complexity of the problem. Certain assumptions were made in the areas of model architecture, resources, arrival processes, service time distributions, and internal business logic. Team PWP first utilized the work from the previous group and then collected new data to perform process analysis on work centers quantitatively. Followed by process analysis on routes and operations, Team PWP obtained production data then performed input data analysis on statistics related to labor, routes and arrival process. Meanwhile, the model architecture was constructed in Arena. Once the model was complete, testing, evaluation, and sensitivity analysis indicated that it did in fact accurately model the system. Team PWP then conducted output analysis that demonstrated the capabilities of the model and how its statistics could be used to inform decision makings.

## 1.7 OUR RESULTS

First, the current markup was evaluated. This markup was shown to have 165 labor shifts between Monday and Friday (e.g. if 2 people worked Monday’s 1st shift, 3 its 2nd, and 1 its 3rd, the number of shifts for Monday would be 2 + 3 + 1 = 6). This markup yielded a total of ~6500 total moves over the course of the week on average, including moves to the trucks. The average utilization was 20% and the average number of helper moves per helper-hour was 6. The final result was that every pallet reached its destination during the appropriate shift.

In an effort to reduce the labor force while still reaching production targets, the GMU Team created a suggested markup by multiplying each shift/day’s allocation for each helper by its utilization and rounding up. The resulting markup consisted of 75 shifts, a reduction of 90. This suggested markup yielded a total of ~6500 total moves over the course of the week on average, including moves to trucks. The average utilization was 40% and the average number of helper moves per helper-hour was 12. The final result was that every pallet reached its destination during the appropriate shift.

The conclusion is that it is possible to reduce labor in certain areas of the markup and reach production targets. The extent to which the suggested markup is implemented is based on production targets and utilization goals. For more details on these statistics and instructions on how to use the model for decision making purposes, please see the Appendix.

## 1.8 OUR RECOMMENDATIONS

Team PWP recommended the *post* to apply a modified labor markup schedule to the warehouse to save labor cost. A more efficient and optimized labor markup could be achieved by comparing the outputs after running the model against different labor markups. Utilizing the output analysis of the model for different schedule would help the *Post* to make labor markup decisions that meet production goals and reduce labor to cost the minimum. Furthermore, Team PWP suggested the *post* to develop stringent input data tracking mechanism to obtain accuracy in numeric values or distributions of input parameters. The values and distributions of input parameters of the model should be as realistic as possible for the model to produce accurate output.

## 1.9 POSSIBLE FOLLOW-ON EFFORTS

As a follow-on effort, Team PWP recommends several efforts that were discussed with the *Post*. First, a future team could provide a graphical user interface (GUI) for the Arena model. This interface would allow the direct use of the model and eliminate the need for either in-depth Arena experience or a theoretical understanding of simulations. It would help provide an easier way to enter input data and read output data. A second improvement would be the development of animation to assist the user with a visual representation of what is occurring within the system. Third, an optimization within the simulation to determine optimal schedule allocations of helpers to meet production targets could be implemented. Lastly, assumptions of the existing Arena model could be explored and eliminated by making model improvements such as seamless transitions of raw ad materials to finished pallets instead of breaking the process into two distinct flows.

# APPENDIX A: MODEL RESULTS

## Appendix A-1: Base Schedule

Table A-1 1 Base Schedule by Helper by Day/Shift



Table A-1 2 Utilization for Base Model



Table A-1 3 Moves per Shift and Helper Zone for Base Model

## Appendix A-2: Suggested Schedule

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Table A-2 1 Suggested Schedule by Helper by Day/Shift



Table A-2 Utilization for Suggested Model



Table A-2 3 Moves per Shift and Helper Zone for Suggested Model

# APPENDIX B: MODEL DETAILS

## Appendix B-1: Model Assumptions

Developing clear assumptions for a model is especially important when determining how it can be applied to real world decisions. It is extremely important that the user of a model be aware of the intricacies of what is being assumed when analyzing the model’s results. Simulation was Team PWP’s choice for model framework and with that come certain assumptions related to model architecture, resources, arrival processes, service time distributions, and internal business logic.

### B-1 1 MODEL ARCHITECTURE

The largest model architecture assumption was the elimination of the truck and receiving dock operations for the ad raw materials. Due to the complexity of this process and the fact that 95% of all the materials ended up at the rack, we felt this was acceptable. Its impact on the resource markup is discussed in the next section. Another model architecture assumption was the splitting of the arrival, processing, and departure processes at the machines and the rack. In the actual system, raw materials arrive at the processing machines, are processed, and leave as a finished pallet. Due to the complexity of the recipes, raw pallets were terminated at the machines, and a separate arrival process was used for the arrival of the finished pallets on the other end, as opposed to modeling the transition. This same concept was adopted at the rack for finished Sunday Packaging arriving and leaving the rack.

Z-Loader loading and unloading had two assumptions. The first was that half the time, the Z-Loader was in a location where the pallet was dropped off and half the time it wasn’t. This was handled by using a triangular distribution that used as parameters 1.5 times the minimum, mean, and maximum time to move the Z-Loader one way. Secondly, pallets that arrived at a busy Z-Loader waited in order under it was available. It was assumed that a helper would put the waiting pallets on the Z-Loader when he/she dropped off another pallet.

The last model architecture assumption was unlimited truck arrivals for finished pallets. Because good data did not exist on when trucks arrivals would occur, it was assumed Loaders/Unloaders would always have a truck to move a pallet onto.

### B-1 2 RESOURCES

The main resources in the model were helpers. Helpers were determined based on a markup of the previous workforce amounts. Loader/Unloader and Deep Reach helper types were in the markup, however, they also worked processes not represented in the model. Because of this, the client determined how many of these helper types to reduce from each shift. This discrete reduction of the labor force to accommodate the missing components not modeled works with the assumption that the components modeled and not modeled are independent of each other.

Additionally, assumptions were made about the routes assigned to helpers. Aggregating helpers into groups that all work with a different set of routes is something that the *Post* does not always do perfectly now, but would like to, so it was modeled that way. That said, assumptions about this process were based on client advice.

### B-1 3 ARRIVAL PROCESSES

While a complete analysis of the data related to the arrival processes in the model determined their distributions were exponential in inter-arrival times and Poisson in terms of arrival rate, this distribution type is still an assumption. Shift/days with less than four pallet arrivals were not considered.

To develop the distributions, Team PWP used data from the week of February 7-12 2011, except for arrivals from the rack of Daily Insert and Sunday Packaging raw ads, which used data from a previous week (i.e. January 17-23, 2011) because of a lack of this data for the main week. It was assumed that the data from these weeks was representative of the system behavior over all weeks and captures the overall number of pallets that needed to be moved within the system over the course of a week.

### B-1 4 SERVICE TIME DISTRIBUTIONS

Route velocities for each helper type and Z-Loader lifting times were assumed to follow a triangular distribution. Because of a lack of good historical data, Team PWP relied on the client subject matter expertise to determine this information. When dealing with subject matter experts to obtain mathematical distributions, the triangular distribution was used because it is was easy to define parameters.

Servicing time for entering and removing pallets from the rack was assumed to be 30 seconds and added to the end of the routes to and from the rack. This was provided to us by the client.

### B-1 5 INTERNAL BUSINESS LOGIC

The internal business logic of the model was determined based on subject matter expertise and system states as well.

It was assumed that 50% of finished Daily Insert pallets went to the Concourse Shipping Dock and 50% went to the North Dock Shipping Lanes. Additionally, it was assumed that 50% of finished Sunday Packaging went to the rack and 50% went to the North Dock Shipping Lanes. It was also assumed that choosing between machines to use (i.e. SLS 1-4 and SLS 5-6) was done uniformly. Lastly, Team PWP assumed that helpers would always choose the Z-Loaders to use that were the least busy.

## Appendix B-2: Model Instructions

Below is a list of instructions for usage of the Arena model:

Getting the Model Ready to Run

1) Create a folder on your hard drive where the models and MS Excel output spreadsheets will live.

2) Save WashPost\_Base.doe, WashPost\_Sug.doe, Markup.xls, HelperMoves.xls, and HelperUtil.xls to the folder.

3) Open both models one at a time and click on “Advanced Process – File”. Here switch the browser location of the three MS Excel output files to where you have saved them on your hard drive.

4) Save the models. Now, you are ready to begin.

Changing the Schedule

The WashPost\_Base.doe model possesses the current markup schedule. The WashPost\_Sug.doe contains the suggested markup schedule. New schedules can be developed and saved as under different model names. To change the schedule:

1) Go to “Advanced Transfer – Transporter” and change the numbers of helpers to the maximum number you will have over the week. Keep in mind that you can start them off as all “Active” or all “Inactive”.

2) Use Halt and Activate modules in the “Advanced Transfer” panel in the Schedule component to turn the helpers off and on based on the shifts. In this component, you can see which sections are designated to which shift.

Changing Arrival Processes

1) Before changing the arrival processes in the model, first calculate them. Do this by summing the total number of pallets that arrive for each arrival process by shift/day. Then, divide this number by 6 to distribute the rate over 6 hours. You can round the number you get.

2) Go to “Basic Process – Schedule” and select the arrival process you would like to change. For each shift, enter the number you calculated for hourly rate across the first 6 hours in the shift. Make the last hour of the shift 0 to allow for helpers finishing up.

Changing the Helper Velocities

1) Go to “Advanced Process – Expression” and select a helper that you would like to change the velocity of.

2) Change the expression to any distribution you would like. Currently, a triangular distribution is used which take a minimum, mean, and maximum velocity as input. Use feet/second.

Changing/Updating the Distances

1) Go to “Advanced Transfer - Distance” and select the list, “All. Distance”. This list contains every combination of paths that a helper might traverse and their inverse, including those that are not ones that pallets would be taken on. This is necessary because every possible route a helper may travel must be represented.

2) You can go in individually and change a distance or copy the entire list to an MS Excel sheet and make a mass update, then copy it back in. Please note that when changing distances, different locations in the model have different names (e.g. NDSL C1.Station and NDSL C2.Station). When making a change in distance, you must make the change for all routes with titles for the locations involved. Also note that every distance has an inverse (e.g. MR1Daily - S5HS and S5HS – MR1Daily) and all of those inverses must be changed also.

3) For a complete list of stations elsewhere in the model than “Advanced Transfer- Distance”, go to “Advanced Transfer – Station” and select the “Name” field AND “Advanced Transfer – Enter” and select the “Station.Name” field. You need both lists to get the full set.

Changing the Internal Business Logic

1) Click on any “Decide” module within the model and change the decision logic to what you would like. It can be attribute-based or probability-based.

Running the Model

1) Click on “Run – Setup” at the top drop-down menus and change the parameters of the run. You must leave the day length parameter at 21 hours. The replication length must be kept between 1 and 5, which represents Monday-Friday. You can also adjust the number of replications to a maximum of 30, which is what the output analysis MS Excel sheets can hold.

2) Click on “Run – Go” at the top drop-down menus.

Using the Output Analysis

Each MS Excel output file has a different use. They are detailed below.

*Markup.xls*

This simply represents the markup you have selected in your Schedule component by helper by day/shift. It will help you ensure you have entered the markup in correctly.

*HelperUtil.xls*

This records the average number of helpers working by helper by shift/day. This is not in itself the utilization percentage. To calculate this percentage, take the number recorded and divide it by the markup amount of that day/shift.

*HelperMoves.xls*

This records the total numbers of moves by helper by shift/day. This can be used for many things such as determining the number of helper moves per helper per hour by helper by shift/day. To do this, divide the number recorded by the number of markup amount of that day/shift; then divide that number by 7 for 7 hours in the shift.

The “Totals” tab records the number of arrivals by varying locations and the number of them that were delivered to their appropriate locations. This is a full week count. A ratio of 1 between the numbers means that everything got to where it was going. This is a good way to measure whether production was met within the week. Remember that the end points are not just the docks, but also the HSs and the rack.

Calculating a New Markup

A good way to baseline a new markup would be to take the current markup used in the model and multiply each helper’s shift/day amount by the utilization. You can round this number up or down depending, but you want to make sure you have at least one helper during shifts when they are needed.

Using the new markup, take a look at how utilization and helper moves change, and see if overall production targets are still met.