Washington Post Fleet Analysis

Project Proposal
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1 Problem Description

1.1 Background

In the fall of 2010 and spring of 2011, the Washington Post requested graduate students from the Department of Systems Engineering and Operations Research at George Mason University (GMU) to assist their Springfield, Virginia plant with determining an efficient method to produce cost savings in their shipping and receiving operations. The GMU team performed data collection and process evaluation, resulting in recommendations for efficiency gain which have since been implemented in the Shipping and Receiving Department.

This year, the client would like to expand the problem scope to determine an efficient method to produce cost savings within their Circulation Operations Department. The Washington Post Circulation Operations Department is looking to find the most cost effective truck run schedule, the most efficient truck fleet combination, the most cost effective driver schedule, and the optimal driver staffing plan needed to deliver Daily and Sunday papers to their 27 warehouses to support on time delivery to residences in the Washington, D.C. area.

For the purpose of shipping products from their Springfield, Virginia plant to their 27 warehouses, the Washington Post's Daily and Sunday packages are broken into four types of delivery products:

- The Daily Paper Advanced Runs are assembled Monday – Friday (6:00am – 9:30pm) for the next day's edition, and are shipped Monday - Friday evenings (6:00pm-11:00pm), needing to be at the warehouses by 11:00pm each day.
- The Daily Paper Headsheets (front page) are assembled Sunday – Friday (11:00pm – 4:00am) for the next day's edition, and are shipped Sunday - Friday (11:00pm – 4:00am), and are required to be at the warehouses by varying times to support on time delivery to residences each morning.
- The Sunday Packages are assembled Monday – Thursday, 3 full shifts per day, and are being shipped Monday – Thursday throughout the week ultimately needing to arrive at the warehouse by Thursday at 11:00pm.
- The Sunday Front Page is assembled Saturday 11:00pm to Sunday 4:00am and is shipped Saturday night 11:00pm to 4:00am with the product required to be at the warehouse at varying times.

The current truck fleet consists of straight trucks (9) which can hold 12 pallets each, tractors with trailers (20), 32' trailers (4) which can hold 14 pallets each, 36' trailers (1) which can hold 18 pallets each, and 48' trailers (13) which can hold up to 22 pallets each. Also, though currently none are leased as part of the fleet, 53' trailers can carry 24 pallets each. The Washington Post leases all trucks in its fleet from one of two companies; Penske provides straight trucks and tractor trailers, and its sister company Robinson Terminal Warehouse provides additional tractor trailers. Trucks are typically leased on a 7 year term, with term end dates varying across the fleet.

The Washington Post's current driver staff is comprised of 30 full time and 30 part time drivers. Of the drivers on staff, 55 have a Class A Commercial Drivers License (CDL) and 5 have a Class B CDL. Class A CDL drivers can drive any truck in the fleet, and are therefore the most expensive by hourly rate. Class B CDL drivers are limited to only driving straight trucks, and have a less expensive hourly rate. All trucks in the current fleet require drivers to have a Commercial Drivers License.

Volume of each product type is variable and subject to change based on inserts such as fliers, coupons, magazines, etc. Expected volume of each product type is not known until roughly a week before the scheduled week of shipment. Given that constraint, the Washington Post Circulation Operations Department develops a weekly schedule the Friday before the next work week, which runs from Sunday to Saturday.

1.2 Problem Statement

The team objective is to maximize the efficiency of the truck run schedule in the Circulations Operations Department at the Washington Post's Springfield, Virginia plant. The efficiencies that are gained are intended to set the basis for work in reducing the operating costs associated with fleet makeup (truck lease and operating costs) and driver staffing plan (employee labor costs).

The Washington Post's Springfield, Virginia facility ships four product types including Daily Paper Advanced Runs, Daily Paper Headsheets, Sunday Packages and Sunday Front Page. The time which each of these four product types is available for shipment, and the time which products of each of these four types is required to be at the warehouses varies and is dependent on product type.

The scope of this project deals with truck schedules, including truck type, needed to facilitate the movement of pallets of the four product types identified above from the Springfield, Virginia production facility to the 27 warehouses to enable timely delivery of Daily and Sunday papers to resident subscribers. The employee schedule is additional work built on the truck schedule and fleet mix and maybe performed by a future semester.

1.3 Stakeholders

The following stakeholders have been identified:

Transportation Division, Julio Pascual – Manager
Circulation Operations, Jim Dean Jr. – Director

2 Preliminary Requirements

2.1 Project Requirements

2.1.1 Our Team shall develop a system requirements document for the system model.

2.1.2 Our Team shall develop a concept of operations.

2.1.3 Our Team shall perform a trade analysis of alternative modeling techniques.

2.1.4 Our Team shall perform model output analysis to make process improvement recommendations to the Washington Post customer.

2.1.5 Our Team shall complete a Project Proposal on 9/22/2011.

2.1.6 Our Team shall provide a one page status report on 10/13/2011.

2.1.7 Our Team shall provide an In Progress Review Report on 10/20/2011.

2.1.8 Our Team shall provide a final report on 12/1/2011.

2.1.9 Our Team shall provide a dynamic system model to the Washington Post customer on 12/1/2011.

2.1.10 Our Team shall provide a final presentation on 12/8/2011.

2.1.11 Our Team shall develop a website to publish all project documentations and results.

2.2 Functional Requirements

2.1.12 The model shall be executable with existing software packages used by the Washington Post customer.

2.1.13 The model shall allow users to manipulate input parameters.

2.1.14 The model shall be able to accept a one week data set, comprised of truck fleet parameters and projected product volumes by product type.

2.1.15 The model shall support dynamic updates to truck fleet mix parameters.

2.1.16 The model shall support dynamic updates to product volumes for all four product types shipped by the Washington Post Springfield production facility.

2.1.17 The model shall determine a one week delivery schedule that optimizes cost given a constrained fleet mix.

2.1.18 The model shall determine a one week driver assignment schedule based on an optimized truck schedule for any given week.

2.1.19 The model shall determine the cost benefit of varying the delivery schedule for any given one week's projected product volume by product type.

2.1.20 The model shall determine the cost benefit of varying the fleet mix.

2.3 Performance Requirements

2.1.21 The model shall support exactly one user at any given time.

2.1.22 The model shall handle a maximum of one week of projected product volume data.

2.1.23 The model shall handle exactly one week of truck fleet parameter data.

3 Process Analysis

3.1 System/Process Analysis

Given the complexities of the system of interest, it is very important that we obtain an in depth understanding of the system and processes that are currently in place at the Washington Post Circulation Operations Department. The system is, and must always be able to sufficiently transport pallets of various types of product from the Springfield, Virginia production facility to 27 warehouses in the Washington, D.C. area.

Currently, the process used to facilitate timely transportation of products produced at the Springfield, Virginia plant involves numerous product types, changing product volumes, varying delivery need times, multiple truck types, numerous routes, and a driver staff qualified with two different types of commercial driver licenses. These components interact throughout the 28 physical facilities in the transportation system, based on extensive scheduling of both truck routes and driver shifts.

Our approach for process analysis will be to work closely with our customer points of contact (POC) to develop an understanding of their current processes and current process limitations. It is crucial that these processes be documented and reviewed by the customer to ensure that our team has a correct and consistent understanding of the current system behavior.

Beyond documenting the present system behavior, it is also vital that we document the needs of the Washington Post customer with respect to the product delivery system. In this case, these requirements will need to be broken down by product type since the business rules for the system vary if the pallets being delivered are made up of Daily Paper Advance Run product, Daily Paper Headsheet product, Sunday Package product, or the Sunday Front Page product. Understanding these business rules by constructing use case scenarios based on each of these product types for a one week shipment schedule will be critical to set the foundation for our model.

3.2 System Data Collection and Analysis

To perform a thorough analysis, we will need to acquire quantitative data for each component of our system that is defined during our process analysis (e.g. truck types, product types, routes, etc.). Conveniently, the Washington Post has implemented a comprehensive data tracking system and is able to provide historical data on things such as product volume and transportation times.

Besides obtaining and analyzing this data, we will need to elicit additional information from our Washington Post POC, including priorities, preferences, and issues that may not been identified through historical data analysis alone.

Once this data has been collected, our team will conduct analysis to determine any holes or area that lack definition within the system. Our goal will be to obtain descriptive statistics for each of the components of the system. To ultimately determine what type of model we should use to facilitate fleet schedule decisions, we will need to exploit our quantitative and qualitative understanding of the product transportation system.

4 Model

4.1 Model Selection and Construction

A trade analysis will be performed to select a method to model the problem. This trade may include varying assumptions, methods, and scope in order to make the model a more feasible product given the short time constraints to produce it. It will also involve researching papers that document solutions to similar problems. The end goal should be a product that the Washington Post team can use to assist them in making decisions.

To satisfy all stakeholder requirements, three models will be constructed. The model will be constructed to provide data to be used to guide leasing decisions that govern future fleet makeup. Luckily, there exists an extensive body of literature on the heterogeneous-fleet multi-trip vehicle routing and scheduling problem (HFMTVRSP) to guide model formulation. Sensitivity analysis will be conducted by adjusting model parameters to reflect projected demands over a multi-year time horizon. The leasing terms for the current fleet vary widely. Some trucks have been recently leased and will be fixed in the fleet for a number of years, while other leasing contracts are nearly expired. This model will provide recommendations to the stakeholders as leasing contracts expire as to how to direct future fleet composition.

Since trucks are leased for multiple years, on a week-to-week basis, the fleet mix is essentially fixed. This reduces the complexity of the problem to a regular vehicle multi-trip routing and scheduling problem (MTVRSP). It is well known that the generalized vehicle routing problem (VRP) is NP-hard. In the case where the model is too large to solve to optimality within a reasonable timeframe, heuristics such as column generation will be used to produce near optimal routing solution quickly.

The second model will provide an optimal solution of truck scheduling that minimizes cost and fits within the fleet constraints. Once this model has been perfected, it will be developed into a tool where stakeholders can dynamically adjust model parameters via a graphical user interface. This will include adjusting the number and locations of distribution warehouses, fixed and variable fleet costs, and demand of each product type at each distribution warehouse.

The first two models together will offer a business case for future changes to the fleet mix while providing a truck scheduling solution consistent with the current fleet. Our model should perform at least as well as the current method and identify possible cost savings through a more optimal truck schedule.

Once optimal routes for each truck have been identified, a crew-scheduling model can be used to assign drivers to trucks. This model will assign drivers optimally to the trucks minimizing cost and considering licensing, scheduling, and regulatory constraints. This too can be a complex problem; however there has been substantial research over the last decade on crew-scheduling in the airline industry that can be drawn from. This third model will be evaluated as additional scope based on the success of the first 2 models. It makes a logical breakpoint for a future project team to evaluate this as a stand-alone problem.

4.2 User Interface

The Washington Post Team expects that readership levels will decline in the coming years which will drive changes in the levels of product being delivered. Due to the changing nature of the distribution operation an optimal solution will be short-lived, and the problem will have to be re-evaluated. Also, the nature of the volume of truck space needed in any given week can vary greatly based on the number of inserts. It's crucial that the model provides a User-Friendly experience that allows the Washington Post team to operate it unassisted in the future with updated parameters.

By providing the Washington Post team with a model that is easy to use/update and utilizes an economical engine to power the model, we'll ensure that they can re-use the model to continually update their truck and driver schedules and re-evaluate their fleet mix as needed.

4.3 Model Parameters and Data Requirements

The Operational Scenario will help define the model's flow.

1. **Current Fleet Parameters**
    - **a.** Straight Trucks (9) which can hold 12 pallets each
    - **b.** Tractors with trailers (20)
        - **i.** 32' trailers (4) which can hold 14 pallets each
        - **ii.** 36' trailers (1) which can hold 18 pallets each
        - **iii.** 48' trailers (13) which can hold up to 22 pallets each
        - **iv.** 53' trailers (0) can carry 24 pallets each
2. **Current Cost Parameters**
    - **a.** Leasing Costs for each type of truck
    - **b.** Cost/mile for each type of truck
    - **c.** Labor costs for class of driver
3. **Route Parameters**
    - **a.** Miles for each valid route between 27 facilities
    - **b.** Speed/time for each valid route between 27 facilities
4. **Driver Parameters**
    - **a.** Regulatory Constraints
        - **i.** Licenses
        - **ii.** Hours driving
    - **b.** Work week availability
        - **i.** Full-Time
        - **ii.** Part-Time
        - **iii.** On-Call
    - **c.** Feel-Good Constraints
        - **i.** Consistent schedule
        - **ii.** Adjacent Days off

4.4 Model Analysis

The models should provide the majority of the analysis to the user interface. It needs to be clear what cost benefit varying the trucks in the fleet. This may have un-intended consequences to the drivers that also need to be considered. The model should also output which sized trucks should be on which routes during a given time period and how many pallets they should be carrying.

5 Project Planning

This problem is challenging and has a large scope. The schedule below lays out milestones and deliverable information that will be critical to delivering a useful product to support the Washington Post Team.

5.1 Deliverables

Deliverable	Date
Problem Description	01 Sep
Problem Definition Presentation	08 Sep
Project Proposal	22 Sep
Status Report	13 Oct
In Progress Review Presentation	20 Oct
Draft Final Presentation	03 Nov
Dry Run Final Presentation	01 Dec
Final Report	01 Dec
Final Website	01 Dec
Final Presentation to Faculty	08 Dec

5.2 Project Schedule

Milestone	Start	finish	dependant on
problem statement	1-Sep	8-Sep	
project proposal	8-Sep	22-Sep	2
document system processes	22-Sep	5-Oct	3
decompose preliminary requirements	22-Sep	5-Oct	3
research existing solutions	22-Sep	5-Oct	3
perform trade analysis on model	1-Oct	10-Oct	6
collect data	20-Sep	15-Oct	5
construct model	10-Oct	1-Nov	7
verify model- assess business case	4-Nov	7-Nov	9
perform sensitivity analysis using model	4-Nov	12-Nov	9
Status Report	10-Oct	13-Oct	
In Progress Review	13-Oct	20-Oct	

Draft Final Presentation	12-Nov	1-Dec		11
Write Final Report	12-Nov	1-Dec		11
Create Final Website	23-Nov	1-Dec		15
Faculty Presentation	8-Dec	8-Dec	14,15	

5.3 Gantt Chart