## Optimization of Fleet Profile -Circulation Dispatch at the Washington Post

In Progress Review

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George Mason University SYST 798/OR 680 October 20, 2011



## Agenda

- Reminder: Problem Description
- Schedule & Status
- Highlight of Progress to Date
  - Document System Processes
  - Data Collection
  - Research Existing Solutions
  - Perform Trade Analysis on Model
- Forward Plan



## WPCD Descriptive Diagram



## Schedule

|  | Task          | Task   |       |
|--|---------------|--------|-------|
| Milestone                                | Start         | Finish | Pred. |
| problem statement                        | 1-Sep         | 8-Sep  |       |
| project proposal                         | 8-Sep         | 22-Sep | 2     |
| document system processes                | 22-Sep        | 5-Oct  | 3     |
| research existing solutions              | 22-Sep        | 5-Oct  | 3     |
| perform trade analysis on model          | 1-Oct         | 10-Oct | 6     |
| Status Report                            | <b>10-Oct</b> | 13-Oct |       |
| collect data                             | 20-Sep        | 15-Oct | 5     |
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| construct model                          | 10-Oct        | 1-Nov  | 7     |
| verify model – assess business case      | 4-Nov         | 7-Nov  | 9     |
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| Draft Final Presentation                 | 12-Nov        | 1-Dec  | 11    |
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## **Document System Processes**

- System and Process Analysis Goals
  - Document current WPCD system structure and behavior
  - Document WPCD system needs and constraints
    - Define business rules by product type that must be kept constant
- No existing documentation
  - Rely heavily on our Washington Post POC



# WPCD Operational Concept Diagram



#### WPCD System Structure



## WPCD System Process

#### act [Activity] WPCD\_Activity\_2 [ WPCD\_Activity\_2 ] Washington Post Newspaper Product Washington Post Facility Washington Post Truck Fleet Washington Post Driver Fleet Warehouse Facility Production Facility Paper Product Produced Paper Available for Shipment Pallets Loaded **Drive Truck to** to Truck Warehouse Pallets Paper Product Unloaded from Received Truck **Drive Truck to** Second Warehouse If another trip on schedule Pallets Paper Product Unloaded from Received Truck **Drive Truck to** Production Facility If no additional trips on schedule

# WPCD System Schedule: Mon-Thurs

|         |   |         | MONDAY - THURSDA |     |    |    |    |     |     |   |  |
|---------|---|---------|------------------|-----|----|----|----|-----|-----|---|--|
|         |   |         | Pr               | od. | Ru | ns | Sł | nip | Tin | n |  |
| 12:00am | - | 1:00am  |                  |     |    |    |    |     |     |   |  |
| 1:00am  | - | 2:00am  |                  |     |    |    |    |     |     |   |  |
| 2:00am  | - | 3:00am  |                  |     |    |    |    |     |     |   |  |
| 3:00am  | - | 4:00am  |                  |     |    |    |    |     |     |   |  |
| 4:00am  | - | 5:00am  |                  |     |    |    |    |     |     |   |  |
| 5:00am  | - | 6:00am  |                  |     |    |    |    |     |     |   |  |
| 6:00am  | - | 7:00am  |                  |     |    |    |    |     |     |   |  |
| 7:00am  | - | 8:00am  |                  |     |    |    |    |     |     |   |  |
| 8:00am  | - | 9:00am  |                  |     |    |    |    |     |     |   |  |
| 9:00am  | - | 10:00am |                  |     |    |    |    |     |     |   |  |
| 10:00am | - | 11:00am |                  |     |    |    |    |     |     |   |  |
| 11:00am | - | 12:00pm |                  |     |    |    |    |     |     |   |  |
| 12:00pm | - | 1:00pm  |                  |     |    |    |    |     |     |   |  |
| 1:00pm  | - | 2:00pm  |                  |     |    |    |    |     |     |   |  |
| 2:00pm  | - | 3:00pm  |                  |     |    |    |    |     |     |   |  |
| 3:00pm  | - | 4:00pm  |                  |     |    |    |    |     |     |   |  |
| 4:00pm  | - | 5:00pm  |                  |     |    |    |    |     |     |   |  |
| 5:00pm  | - | 6:00pm  |                  |     |    |    |    |     |     |   |  |
| 6:00pm  | - | 7:00pm  |                  |     |    |    |    |     |     |   |  |
| 7:00pm  | - | 8:00pm  |                  |     |    |    |    |     |     |   |  |
| 8:00pm  | - | 9:00pm  |                  |     |    |    |    |     |     |   |  |
| 9:00pm  | - | 10:00pm |                  |     |    |    |    |     |     |   |  |
| 10:00pm | - | 11:00pm |                  |     |    |    |    |     |     |   |  |
| 11:00pm | - | 12:00am |                  |     |    |    |    |     |     |   |  |

- Monday Thursday daily
  schedule is consistent from a
  shift perspective
- Daily details are variable
  - Product availability times for various warehouse locations
  - Product volume





# WPCD System Schedule: Fri-Sun

|                   | FRIDAY |      |      | SATURDAY |       |      |      | SUNDAY |       |      |      |      |
|-------------------|--------|------|------|----------|-------|------|------|--------|-------|------|------|------|
|                   | Prod.  | Runs | Ship | Time     | Prod. | Runs | Ship | Time   | Prod. | Runs | Ship | Time |
| 12:00am - 1:00am  |        |      |      |          |       |      |      |        |       |      |      |      |
| 1:00am - 2:00am   |        |      |      |          |       |      |      |        |       |      |      |      |
| 2:00am - 3:00am   |        |      |      |          |       |      |      |        |       |      |      |      |
| 3:00am - 4:00am   |        |      |      |          |       |      |      |        |       |      |      |      |
| 4:00am - 5:00am   |        |      |      |          |       |      |      |        |       |      |      |      |
| 5:00am - 6:00am   |        |      |      |          |       |      |      |        |       |      |      |      |
| 6:00am - 7:00am   |        |      |      |          |       |      |      |        |       |      |      |      |
| 7:00am - 8:00am   |        |      |      |          |       |      |      |        |       |      |      |      |
| 8:00am - 9:00am   |        |      |      |          |       |      |      |        |       |      |      |      |
| 9:00am - 10:00am  |        |      |      |          |       |      |      |        |       |      |      |      |
| 10:00am - 11:00am |        |      |      |          |       |      |      |        |       |      |      |      |
| 11:00am - 12:00pm |        |      |      |          |       |      |      |        |       |      |      |      |
| 12:00pm - 1:00pm  |        |      |      |          |       |      |      |        |       |      |      |      |
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Friday – Sunday daily schedule is unique

 Account for differing weekend products and deliveries





## Data Collection

- System Data Collection and Analysis
  - Collect quantitative data for each system component
    - Have received 2 full months worth of shipping data
      - WPCD working on pulling additional 10 months
    - Have also received truck fleet mix, truck pallet capacity, and facility address list
    - Washington Post has comprehensive data tracking system
  - Elicit additional information from POC
    - Visited the WPCD Production Facility in Springfield, VA
    - Collected data that was not obvious through historical data analysis
    - Priorities, preferences, external influences, etc.
    - Sent follow-on questionnaire on scheduling process



## Model Approach: Efforts to Date

- Research Existing solutions
- Perform Trade Analysis on Model











Arcs are feasible flow. Here product flow is restricted to waiting at the depot.

Time





Arcs determined by travel times between warehouses

Time





- Multi-commodity min-cost flow problem
- Input: network, production schedule, truck availability
- Output: How much of each product on each truck type as well as the route schedules for all trucks
- Solves fleet mix problem



- Multi-commodity min-cost flow problem
- Input: network, production schedule, truck availability
- Output: How much of each product on each truck type as well as the route schedules for all trucks
- Solves fleet mix problem
- Much more compact than initial vehicle routing formulation



- Objective: Minimize costs of driving the trucks
- Constraints: Product flow across arc is capacitated by truck type. (Arcs between the same location are uncapacitated)
- At most one truck type across each arc
- $\succ \quad Flow in = Flow out$



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