University of Pennsylvania

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ESE Senior Design

Stadium Traffic Emissions

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1st Project Report

1. Introduction

1.1 Overview

Stadium Traffic aims to reduce the carbon emissions from people going to and from sports games. In particular, our project will focus on the Philadelphia Eagles and Phillies stadiums. We aim to build a model that can be used to quantify the carbon emissions generated due to people coming to and going from games. We will then develop solutions to reduce the number of people coming by cars or leave over longer time period and develop a traffic routing algorithm, aiming to reduce the carbon emissions from idling cars waiting to leave the stadium. We will test these on our model to find a successful combination. If we can get the cooperation of Phillies/Eagles and Philadelphia Police Department, we hope to work with them to implement the results of our project.

1.2 Motivation

All of us have been to large gatherings like sports games, concerts or conferences and can therefore relate to the traffic problems when everyone is trying to leave at the same time at the end of the event. However, what most people don't realize is the environmental effect of this traffic. Our project aims to find solutions to reduce this traffic and hence reduce the emissions while cars idle in parking lots trying to leave.

The project is focusing on the Philadelphia Eagles and Philadelphia Phillies stadiums. Sports events draw huge crowds at peak traffic hours and are therefore a great instance on which to model our project. The Eagles are also undertaking a Go Green! initiative, which is a push towards becoming more environmentally conscious. Some initiatives that they have taken are the use of renewable energy sources for their power consumption and using cups and plates made from recycled materials. We believe that we can get the support of the Eagles for our project, as it can be part of the Go Green! initiative and further reduce the carbon footprint of the stadium.

When the football or baseball game ends, everyone tries to the leave the stadium at the same time. Although traffic police conduct the traffic, they do it in a haphazard way. Furthermore, the decision of which gates to be open and which ones to remain closed is also done using intuition rather than any efficiency-maximizing algorithm. We saw this inefficient process as an opportunity to develop an algorithm to reduce car idling time and carbon emissions.

1.3 Project Goal and Objectives

Although the overarching aim of our project is to reduce carbon emissions due to people going to/from the sports games, we broke this down into certain specific and measurable objectives:

1. Develop a comprehensive model of transportation to and from the stadium.
2. Quantify the total emissions due to transportation to/from games.
3. Develop a tool to simulate the emissions impact of various initiatives to reduce private transportation usage (e.g. offering a discounted drink to someone who rides the SEPTA).
4. Create an algorithm to optimally route exiting vehicle traffic according to total emissions generated.
5. Develop a method for the Philadelphia traffic police to implement the traffic routing recommendations of our project.

The success of each of the objectives can be measured and how we would measure the success is stated below:

We would consider a success model one that takes inputs such as trip distribution, number of attendees, start and end time and produces outputs such as average idling time and number of cars.

The aim of the project is to reduce carbon emissions, so we need to be able to measure and quantify carbon emissions from idling cars.

Our model should be able to quantify the effect of different incentives on carbon emissions so that we can test different strategies and find the optimal combination.

Optimal routing of traffic can impact carbon emissions from idling cars, so we need to create an algorithm that can be constraint optimized. A working algorithm can help the traffic police conduct traffic in a more organized manner.

Having a front-end system that can be used by the Philadelphia Police will allow our algorithm to be implemented and hence allow our project to have an impact. Therefore we need a computer or phone application that can be used by the police while conducting traffic.

1.4 Constraints

With any ambitious project, there are always certain constraints and we have recognized the constraints of our project so that we can be prepared to work around them.

The main constraint is the cooperation of the Philadelphia Phillies/Eagles and Philadelphia Police Department because without their cooperation we cannot implement our project. However, our advisor Dr. Huemmler has good relationships with both organizations and has been trying to get their support for the project.

Another constraint is the team's lack of experience with transportation engineering. Since the project involves the understanding, modeling and optimizing of transport systems, this would be a constraint. However, we have taken an initiative to get the help of Professor Vukan Vuchic, a senior professor in transport engineering, and began familiarizing ourselves with relevant transport systems concepts under his guidance.

Finally, our last constraint is the data collection required to build a representative model. However, we have been trying to get the required information from the Phillies, Eagles, and other government departments.

2.0 Discussion of Previous Work

2.1 Group Members' Prior Work

One of our group members, Felipe Ochoa, has had extensive experience working with Penn Transit to improve the dispatching efficiency of their bus operations around campus. This work has allowed for in-depth understanding of queuing theory and demand generation, which will be extremely useful in our module about fans taking cars to the game. Using elements of the prior project, combined with additional concepts from traffic engineering, we will be able to develop an accurate model.

2.2 Scholarly Work

2.2.1 Innovative Methods for Collecting Data and for Modeling Travel Related to Special Events

The planning authority in Phoenix, Arizona, MAG, undertook an extensive project in 2011 to develop a model to understand transit movement to planned special events in the region. Our chosen topic, sports games, falls under the category of a planned special event. Their paper identifies the proportion of special events patrons who utilized light rail v. alternative modes of transportation and how they thought about modeling demand and modal choice for this event. We hope to utilize their thinking to support our own idea generation on how to model sports patrons. Our project will be going above and beyond their project by specifically looking at sports games, narrowing in on a specific type of "planned special event" and developing a comprehensive understanding of modeling travel related to these events.

2.2.2 Transportation Engineering Basics, 2nd Edition

This is a textbook that clearly describes how a travel demand model is created through the components of Trip Generation, Trip Distribution, Mode Choice and Trip Assignment. We will be trying to understand the motivation for Trip Generation, which is based on Trip Purposes as specified in the book. The two purposes relevant for our project are HBO (Home Based-Other) and NHB (Non-Home Based). We hope to extend the information in the book on these purposes and develop a trip generation model that accurately reflects the proportion of these HBO and NHB trips are to sports game in order to quantify the demand generated.

We also hope to use the Trip Assignment information contained in the book and push the envelope to understand Trip Assignment for sporting events.

2.2.3 Trip Generation, 8th Edition

This database details various data patterns related to Trip Generation. We will be able to use the information contained herewith, specifically the information related to the special events travel, e.g. sports games and movies. We hope to extend the work by conducting first-hand research to grow our dataset and make our predictions and algorithms that much more accurate.

3. Strategic Plan

The driving principle behind our strategic plan can be summarized as "Benchmark, then improve." Our project will therefore first focus on computing 'sensible' emissions values for an average game, and will then develop a full model to quantify the impact of different policies that could be put in place. In engineering terms, we are first calculating the equilibrium or "trim" condition and then we will focus on disturbances away from it.

3.1 System Proposed Approach

The approach to both problems will of necessity be similar, and our aim is to design our solution to the first problem with a great deal of flexibility so that it may be readily adapted for use in the second phase of the project. Our phase 1 model will have five main components that correspond to the four steps of the UTMS plus a GHG calculator. The blocks described below correspond to the block diagram shown in figure 1.

- **Trip Generation** We will need to gather data on the geographic distribution of the fans that attend the games. We hope to obtain a good amount of data from the Eagles to aid in this section. Absent that data, we will have to resort to theoretical models commonly used in the industry, such as the Gravity Model. We will also be gathering data on timing of the trips, either through direct observation, or ideally from already existing records.

- **Trip Distribution** This step in the modeling is straightforward, since we know that fans are traveling to and from the stadium (or a nearby parking lot).
- **Mode Choice** This phase involves matching each trip in the database to a mode of travel (i.e. Car vs. SEPTA vs. Bus). We plan on using parking-lot data to estimate car use, and, if possible, get station-level information directly from SEPTA. A variety of theoretical models exist to help validate the gathered data. [2]
- **Trip Assignment** Is the selection of the specific lines, streets, highways, and stations that each trip will follow. At this stage, we will break the model into subsystems for each of the possible means of transportation.
    - **SEPTA Trains** A great deal of information is available on the website regarding lines and schedules that we have used to build a software representation of the network. With some well-established linear optimization algorithms, we will be able to model the exact path taken for every trip assigned to SEPTA trains.
    - **Buses** Schedules and stops are also available at www.septa.org, and we will merge this database with the information available on Google Maps to obtain location data. There are also well-established algorithms we can use to model the paths of every trip.
    - **Cars** Our car model will be split in two:
      (a) At a "micro" level, we will model the road network in and around the stadium parking lot based on existing databases complemented with hand-input data that we extract from maps and planning documents. This portion will be used to model the exiting cars, since we believe the congestion at the end of a game results in substantial GHG emissions.
      (b) At a "macro" level, we will use the same TAZs as in the trip generation phase, and calculate a sample path to the stadium based on highways and main roads. We will have to encode the network of such roads and use our own algorithms. Alternatively, depending on the resulting number of TAZs, and subject to special authorization, we could use the Google Maps API to programmatically retrieve routing information.
    - **GHG Calculator** This subsystem will be a memoryless function mapping a trip to an estimated emissions value. Our preliminary assumption is that trips taken on public transit contribute no additional GHG, since we are taking the bus and train schedules as given. For cars, there are a multitude of published methods for estimating emissions. We will have to estimate a fleet profile (average age and size) to use one of these models. We expect that it will be a function of total highway distance/time, local street distance/time, and idling time. When properly built, the output from this subsystem will be our first main deliverable.

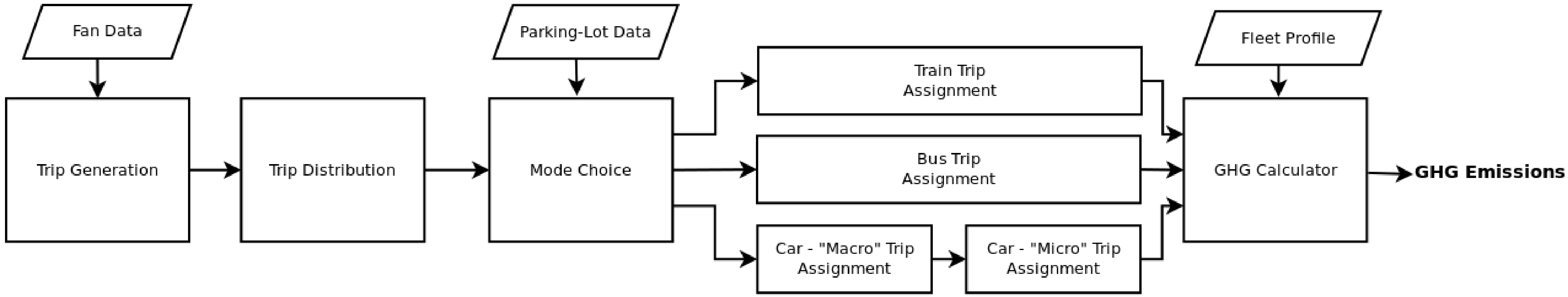


Figure 1: Block diagram for phase one

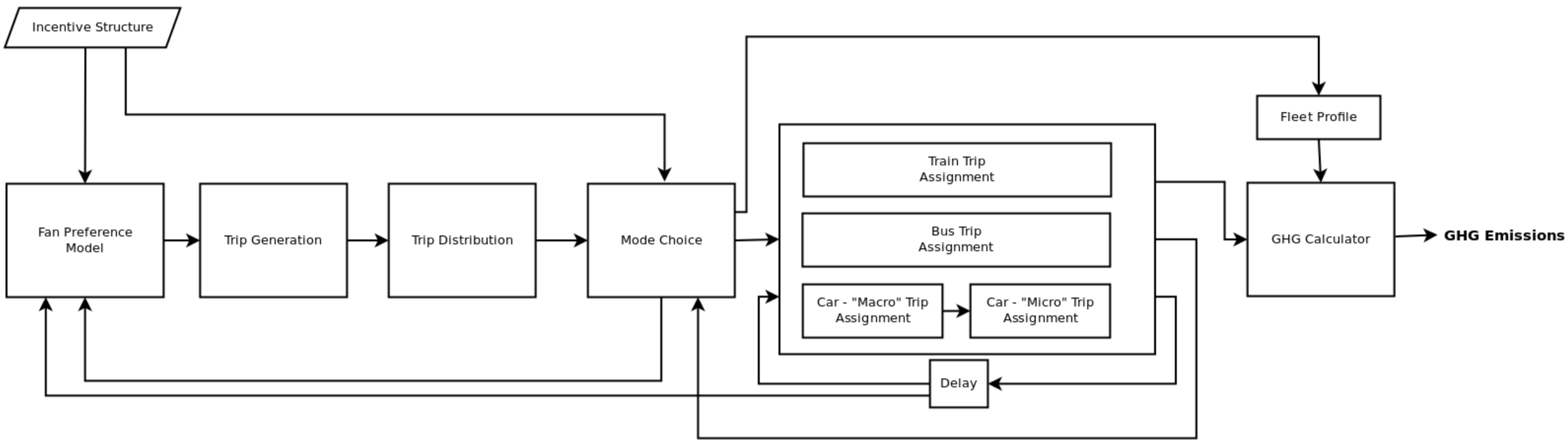


Figure 2: Block Diagram for phase two

For the second phase of the project, as mentioned above, we will seek to leverage as much of the modeling work from phase one as possible. The goal for this phase will be to focus on converting the existing model into a usable simulator. A key objective will be incorporating a variety of inter-system feedback mechanisms that will allow for a more accurate model. There will of course be a trade-off between complexity and accuracy at this stage that we will have to explore. Since there may be limited opportunities to validate our model (until the next season begins), a key performance metric will be the consistency of results, which in technical terms, means that the system should reject small disturbances in the inputs. Conceptually, changing the base fare for SEPTA or increasing the cost of parking by small amounts should not result in wildly different behavior. This sensitivity will be a key measure we will use in determining the right level of complexity to build into the model.

Some examples of feedback mechanisms we are considering at this stage are:

- **Congestion Effects** If a fan spends 45 minutes stuck in the parking lot unable to move, we expect that fan to be more likely to take the train for the next game. A more detailed discussion of the fan model lies below.
- **Scheduling Effects** If SEPTA notices trains traveling fuller on game days, they may choose to alter schedules in the future.
- **Uncertainty Effects** As fans try different modes of transportation, they may refine their predictions of travel times and convenience.
- **Fleet Composition Changes** We suspect the fans that are most likely to start using public transit may have cars with above-average fuel efficiency, whereas the fans that take their trucks to tail-gate parties will likely continue to use their less-efficient cars. These effects would alter the fleet profile and hence average emissions calculations.

Regardless of what feedback loops we ultimately incorporate, we will have to build a model of the fans' utilities, to capture the effects of the various incentive schemes on trip generation profiles. At this stage we expect we will be using an agent-based technique for this subsystem, which will have as inputs the TAZs and some demographic data. Cooperation from the Eagles will be important in fine-tuning this part of the model.

The expanded model can be seen in the block diagram in figure 2. We have included the incentive structure as an input in the diagram. We expect to make a GUI for this input to the model.

3.2 System Specification

Our end system must have a GUI that can be used by Eagles management to input proposed incentives and that will output the projected change in GHG. The input must be intuitive and friendly enough that it does not require a manual for a user of average computer literacy to learn to use it in 10 minutes or less. Additionally, once a user is familiar with the interface, varying parameters on a proposed incentive program should not require more than 2 minutes of the user's time.

The back-end must be flexible and have a documented API so that a software developer may write extensions to the model (e.g. different incentive types) or refine sub modules (e.g. a more efficient traffic assignment subsystem) without having to modify the other components of the software. Additionally, the model must be fast enough so that initial estimates of GHG emissions under certain incentive schemes may be computed within 5 minutes. In addition, detailed logs and reports (e.g. emissions over time graphs) should be accessible to a more knowledgeable user through the same GUI.

The program must handle improper input robustly and must be able to deal with exceptions and errors gracefully. Specifically, a user of average computer literacy should be able to understand error messages, and, in a worst-case scenario, should be able to simply reset the application to restore functionality.

The subsystem specifications are as follows:

- **Trip Generation** The module will have to interface with a database of TZAs and, if possible, a database of sanitized user data in strict XML format. It must output a list of trips specifying the origin and time of each one. This module should not take more than 5 seconds to generate 50,000 trips (excluding loading time).
- **Trip Distribution** This module must pass through the list from the trip generation module.
- **Mode Choice** This module will have to read in sanitized parking-lot data in SQL as well as station-level usage information and TZA demographic profiles. It must accept the list from the trip distribution module and assign a mode choice to each entry in the list. Its output will be a vector of the different trips in each category and some summary statistics for each mode (e.g. utilization percentage). It should not take more than 10 seconds to assign choices for 50,000 trips (excluding loading time).
- **Trip Assignment**
    - **SEPTA Trains** This module must read in a line and schedule XML database and accept an input of trip origin and time pairs. For each trip, it will have to calculate the most direct path to the stadium, subject to its capacity constraints. It must then compute summary statistics to be output along with the trip list. It should not take more than 1 minute to route 50,000 trips (excluding loading time).
    - **Buses** The requirements for this module are identical to that of the SEPTA Trains module.
    - **Cars** The two car modules together should take more than 1 minute to route 50,000 trips (excluding loading time).
        - (a) The "Micro" module should accept the list of trips and must read in a database of the road network in and around the stadium. It must then compute total time per car to reach the highways/main roads as well as total idling time.
        - (b) The "Macro" module should accept the same list of trips as the "Micro" module and should compute total highway and secondary road times across all trips. Optionally, it will have to interface with the Google Maps API.
    - **GHG Calculator** This subsystem will have to process the outputs from the trip assignment modules and compute an overall level of GHG emissions. This module should not take more than 10 seconds to run for 50,000 total trips.

3.3 Hardware and Software Requirements

3.3.1 Hardware Requirements and Design Approach

The hardware requirements for this project will feature towards the tail end of the project. The end-user (be it the Eagles/Phillies or the policemen directly traffic), will be receiving a finished piece of software from us, which would require specialized hardware to deal with it.

In order to make the software/algorithm we create generalizable, we will be utilizing a popular hardware choice of either a personal computer or a portable device (iOS/Android).

The choice will be made upon further discussion with the Eagles and at this time we are unable to provide reasons for a technical hardware choice.

3.3.2 Software Requirements and Design Approach

The software we create will be created primarily in Matlab and Python. The requirements we have from our software will be as follows:

- Modularizable. We should we able to switch out one implementation of the train model, for instance, and replace it seamlessly with another, more efficient implementation.
- Scalable. It should be able to handle a large number of inputs and not break under scale.
- User-Friendly. We want the final output, or GUI, to be extremely user-friendly and it should be operational without a manual.

The software here isn't a complement to the hardware; in fact the actual crux of our project is based on the software. As a result, defining the specific functions of our software would be equivalent to defining the scope for this project, which is done through this 1st Project Report. In summary, we will be looking to create a model that takes in data about demand generation and incentives and uses that to determine the modal usage of transportation to Eagles games. Finally, we will be using the model to determine the amount of time cars idle and based on expected CO_2 emission rates, we will be determining the impact of the incentives inputted into the model. We will also be developing a module to incorporate feedback, allowing for "state" in our model (i.e. prior experiences impact future choices).

3.4 Tests and Demonstration

N/A

3.5 Schedule Gantt Chart

The schedule consists of the different tasks that we estimate we will need to accomplish in order to have a successful project. The tasks can be broken up as those falling into

- Planning and design
- Creating the required subsystems
- Integrating the subsystems into one system
- Implementation.

Each task is assigned to only one individual although others may also be working on the tasks, but the assigned individual is accountable to get it done correctly and on time. Based on the Gantt chart and schedule it is clear that we aim to work consistently over the course of the year to meet the milestones (course requirements) and also aim to get some work done over winter break so that we don't fall behind schedule.

Our current status is that we are ahead of schedule in some tasks, whereas we are behind schedule in other tasks. However, this is not as much of a concern to us as being completely behind schedule because we can alter resource allocation to reconcile the variance and bring the project back on schedule.

The two areas where we are behind schedule are:

(a) Working with the Philles/Eagles and
(b) Working with the Philadelphia Police Department.

This can be attributed to the major constraint mentioned in the introduction. Dr. Huemmler has been trying to get us in touch with them, but so far they have not been very cooperative. However, we cannot allocate more time to this to bring us back on schedule until we have established contact. But after that we can devote more resources to the subtasks to bring it back on schedule.

The tasks where we are ahead of schedule are the calculation of carbon emissions. We over-estimated the time it would take to research and find the necessary data.

4. Nomenclature

- **GHG**: Greenhouse gases. We mostly mean Carbon Dioxide, but we use the term GHG since emissions are highly correlated across types in this application.
- **SEPTA**: Southeast Pennsylvania Transit Authority. Manages the commuter rail, the subway, trolley, and bus systems in and around Philadelphia
- **TAZ**: Traffic analysis zone. Used in modeling the UTMS. It involves dividing a geographical area into units that have sufficiently similar transit and demographics to treat as one for the purposes of the model.
- **UTMS**: Urban Transportation Modeling System. A commonly used framework to model traffic demand and flows.

5. References

[1] Arun Kuppam, et al. "Innovative Methods for Collecting Data and for Modeling Travel Related to Special Events," Prepared for presentation and possible publication at the Transportation Research Board, Washington, D.C. January 2011

[2] Narasimha Murthy and Henry Mohle, Transportation Engineering Basics, American Society of Civil Engineers, 2nd Edition July 2001

[3] Trip Generation, 8th Edition: An ITE Informational Report, ITE December 2008

A1. A Documented Module of Code

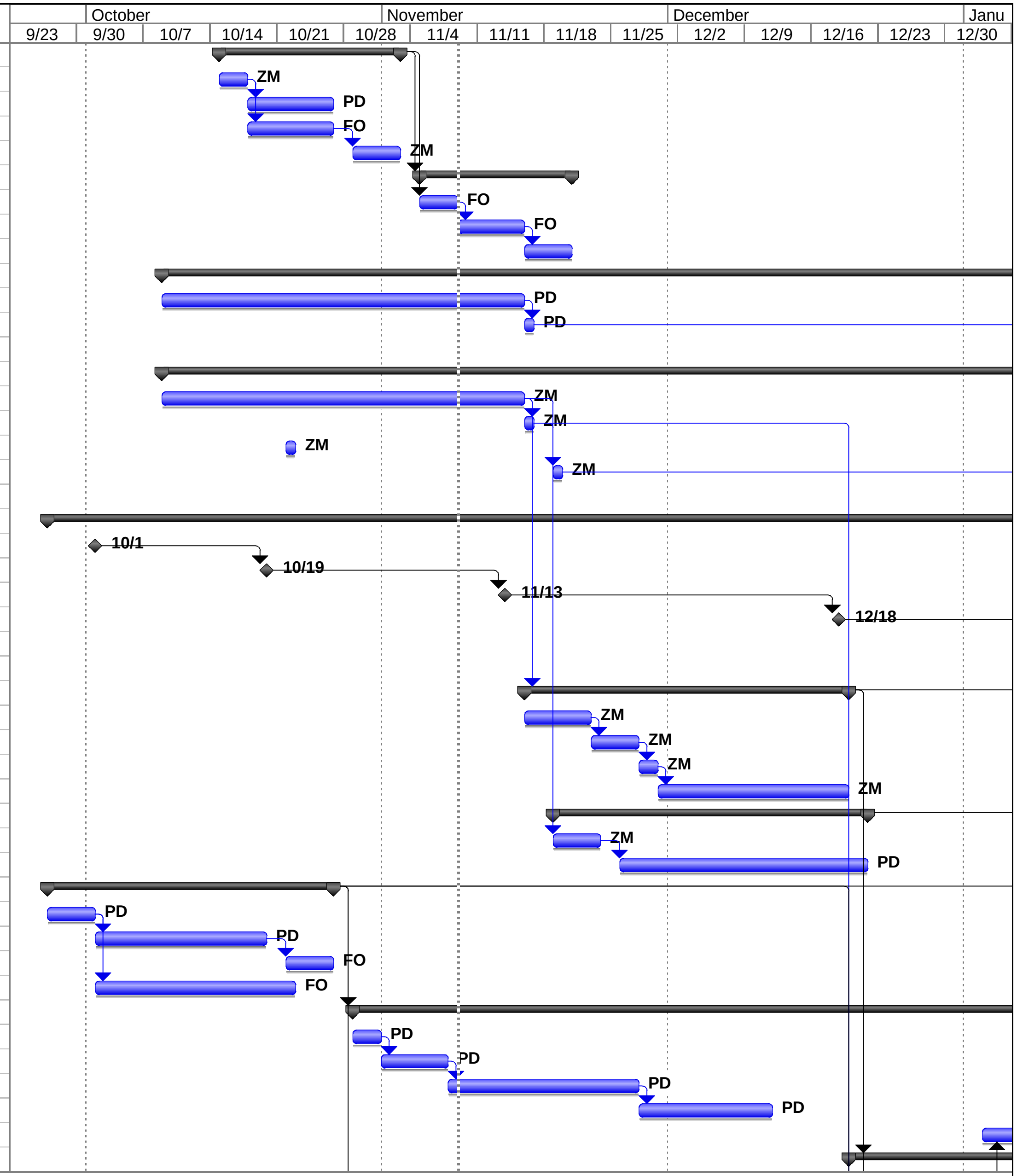
```
#! /usr/bin/env/python3

"""
Title: SEPTA Scrubber
Version: 1.2
Author: Felipe Ochoa
Date: 3 November 2012
Last Backup: 3 November - Dropbox
Description:
    stations.py reads in an xml file containing a list
    of station elements with name and url subelements.
    It fetches those urls and tries to extract the lines
    serving those stations from the websites. It updates
    the xml and saves the updated list into a (potentially)
    new file.

    usage: $ pythonhon stations.py xml-file-name [output-name]

Version History:
1.2 3 November 2012
    - Fixed issue in parsing some HTML for the parking lots
1.1 13 October 2012
    - Modified code to use regular expressions
    - Refactored several methods into a class
1.0 7 October 2012
    - Built initial script
"""

import xml.etree.cElementTree as ET
import urllib.request
import re
from urllib.error import HTTPError


class Station:

    LINES_RE = re.compile("<p>This station is served by:<br ?/?>"
                          "(.+?)</p>", re.DOTALL)
    BREAK_RE = re.compile("<br ?/?>")
    PARKING_RE = re.compile('<table[^>]*>\s*<tr>\s*<td[^>]*>'
                            '<h2 class="normal">Parking</h2>'
                            '.*</table>', re.DOTALL)

    def __init__(self, element):
        self.element = element
        assert (self.element.find('url') is not None)
        self._html = ''
        self._lines = []
        self._parking = []

    @property
    def url(self):
        return self.element.find('url').text

    @property
    def html(self):
        if not self._html:
            self.update_html(self.url)
        return self._html
```

```
    def update_html(self, url):
        # UTF-8 encoded checked by hand on a couple of urls
        try:
            self._html = urllib.request.urlopen(url).read().decode('utf8')
        except HTTPError as e:
            self._html = "HTTP Error #" + str(e.code)

    @property
    def lines(self):
        if not self._lines:
            self.update_lines()
        return self._lines

    def update_lines(self):
        section = self.LINES_RE.search(self.html)
        try:
            section = section.group(1)
        except AttributeError:  # No match found
            self._lines = ["REGEX ERROR"]
            return
        section = section.strip()
        section = self.BREAK_RE.sub("\n", section)
        # subbing <br>s may result in double newlines, and hence blank
"entries"
        # That's why composition below is filtered
        self._lines = [s.strip() for s in section.splitlines() if
s.strip()]

    def set_lines(self):
        lines = self.element.find('lines')
        if lines is None:
            lines = ET.SubElement(self.element, 'lines')
        for line in self.lines:
            el = ET.SubElement(lines, 'line')
            el.text = line

    @property
    def parking(self):
        if not self._parking:
            self.update_parking()
        return self._parking

    def update_parking(self):
        section = self.PARKING_RE.search(self.html)
        try:
            section = section.group(0)
        except AttributeError:  # No match found
            self._parking = [("REGEX ERROR", 0, 0)]
            print("Regex error at " + self.url)
            return
        section = lowercase_tags(section).replace(' ', '')
        try:
            table = ET.fromstring(section)
        except ET.ParseError:
            try:
                # The first row does not appear to be closed properly
                # i.e., the terminal "</tr>" appears as "<tr>" instead
                section = section.replace("<tr>", "</tr>", 2)
                section = section.replace("</tr>", "<tr>", 1)
                table = ET.fromstring(section)
```

```
            except ET.ParseError as e:
                self._parking = [("MALFORMED HTML", 0, 0)]
                print("Malformed HTML at " + self.url)
                print(section)
                print(e)
                return
        rows = list(table)[1:]  # :FIXME:
        self._parking = []
        for row in rows:
            if len(row) == 1:
                # There is no parking. HTML should look like
                # <tr><td colspan="4">There is no parking available at this
                # station.</td></tr> with some whitespace thrown in.
                assert (row.find('td').text ==
                        "There is no parking available at this station.")
                self._parking = [('N/A', 0, 0)]
            else:
                assert len(row) == 4
                # Entries are: SEPTA, Spaces, Availability, Price
                entries = row.findall('td')
                del entries[2]
                def get_text(e):
                    t = e.text
                    try:
                        return t.strip()
                    except AttributeError:
                        return ''
                self._parking.append(tuple(get_text(td) for td in entries))

    def set_parking(self):
        pt = self.element.find('parking-lots')
        if pt is None:
            pt = ET.SubElement(self.element, 'parking-lots')
        for kind, size, price in self.parking:
            lot = ET.SubElement(pt, 'parking')
            t = ET.SubElement(lot, 'type')
            t.text = kind
            s = ET.SubElement(lot, 'size')
            s.text = size
            p = ET.SubElement(lot, 'price')
            p.text = price or "0"  # Parser ignores zeros, apparently


HTML_TAG = re.compile(r"</?([:_A-Za-z][:_A-Za-z\-]*) ?[^>]*>")
def lowercase_tags(html):
    """Converts all tag names in a block of html to lowercase."""
    def lowerize(match):
        full = match.group(0)
        name = match.group(1)
        return full.replace(name, name.lower())
    return HTML_TAG.sub(lowerize, html)


if __name__ == "__main__":
    import sys
    if len(sys.argv) > 3:
        print(__doc__)
        sys.exit(1)
    try:
        xmlfilename = sys.argv[1]
    except IndexError:
```

```
    print(__doc__)
    sys.exit(1)
try:
    outname = sys.argv[2]
except IndexError:
    outname = xmlfilename

tree = ET.parse(xmlfilename)
stations = [Station(e) for e in tree.iter(tag='station')]
for station in stations:
    station.set_lines()
    station.set_parking()
tree.write(outname)
```

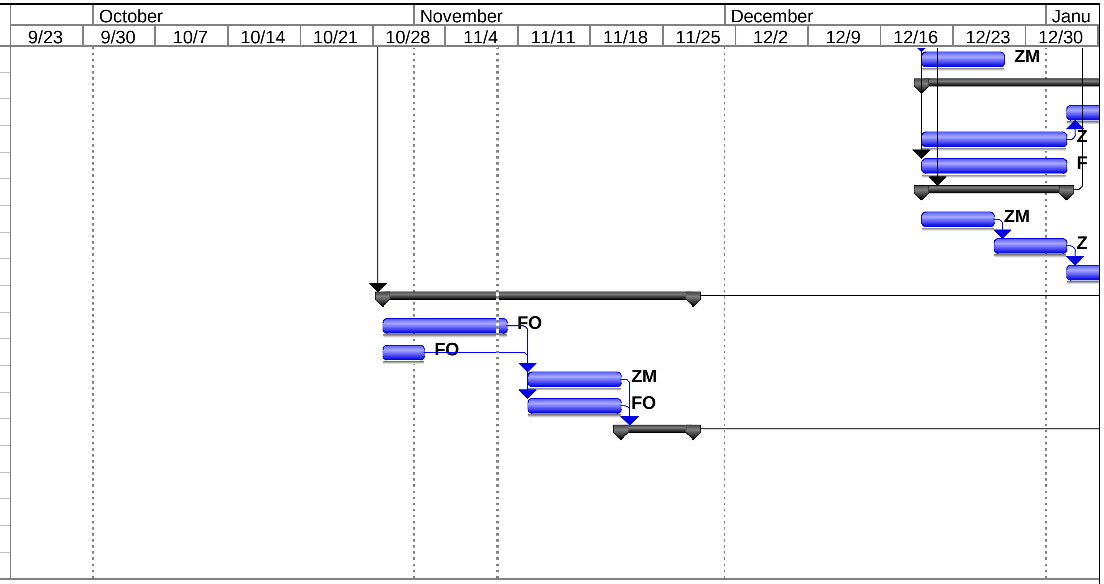
ID	Task Name	Resource Names
1	**Gain understanding of transport systems**	**FO**
2	Meet with Prof. Vuchic	ZM
3	Research on Traffic Organizations in Philadelphia	PD
4	Research on Transport engineering basic concepts	FO
5	Research Distribution Model	ZM
6	**Design Transport System Model**	**FO**
7	Come up with system block diagram	FO
8	Define subsystems	FO
9	Define linkages between subsystems	
10	**Work with Philadelphia Police Dept**	**PD**
11	Establish contact through Prof. Heummeler	PD
12	Meet contact to understand current traffic routing system	PD
13	Meet to discuss implementation ideas	PD
14	**Work with Phillies/Eagles**	**ZM**
15	Establish contact person through Prof. Heummler	ZM
16	Meet with contact person in Phillies/Eagles	ZM
17	Visit stadium to analyse problem (and watch a game)	ZM
18	Review meeting to discuss objectives	ZM
19	Review meeting to obtain feedback	ZM
20	**Complete course requirements**	**FO**
21	Proposal	ZM
22	First presentation	PD
23	1st Project Report	FO
24	Phase 1 Report	ZM
25	Phase 2 Report	PD
26	Demo Day	FO
27	**Develop Football Game Demand Generation Model**	**ZM**
28	Research geographic profile of fans	ZM
29	Profiling of fans in attendance	ZM
30	Repeat attendance (I.e. season ticket holders, etc.)	ZM
31	Produce demand generation model	ZM
32	**Develop Model to Quantify Incentive schemes (Tailgate model)**	**ZM**
33	Produce linitial list of potential incentives	ZM
34	Create model that accounts for Individual preferences	PD
35	**Develop Train transit model**	**PD**
36	Create network model of Stations and lines	PD
37	Program algorithm to collect Schedule/capacity data	PD
38	Connect train transit model to overall geographic model	FO
39	Create Station level model (for exiting)	FO
40	**Develop Bus transit model**	**PD**
41	Collect data about Schedule and capacity	PD
42	Understand scope for additional buses	PD
43	Connect this model into overall geographic model	PD
44	Plug into traffic model	PD
45	Estimate additional emissions impact from this model	ZM
46	**Develop Car transit model**	**ZM**



Project: SeniorDesignSchedule4.mpp
Date: Fri 11/9/12

Task		Milestone	◆	External Tasks	
Split		Summary		External Milestone	◆
Progress		Project Summary		Deadline	⇩

ID	Task Name	Resource Names
47	Conduct research to profile current car uses	ZM
48	**Model road network**	**ZM**
49	Code Macro scale network (highways, general directions, etc.)	ZM
50	Code Micro scale network (parking lot streets, corners, signals)	ZM
51	Create Agent-based traffic model	FO
52	**Estimate emissions**	**ZM**
53	From idling	ZM
54	Per distance	ZM
55	Analyze scope for Pareto improvement in traffic routing	ZM
56	**Integrate subsystems into overall Transit model**	**FO**
57	Model Constraints into the model (e.g. Eagles budget)	FO
58	Understand collaborator constraints (SEPTA/police cooperation, etc.)	FO
59	Build the Distribution model (including current data)	ZM
60	Build the Assignment model (including current data)	FO
61	**Design Feedback loops**	**FO**
64	**Develop Front end for implementation**	**PD**
65	Specify end-user requirements	PD
66	Determine flexibility requirements	PD
67	Determine platform (iPad vs smartphone vs pc?)	PD
68	Design GUI	PD



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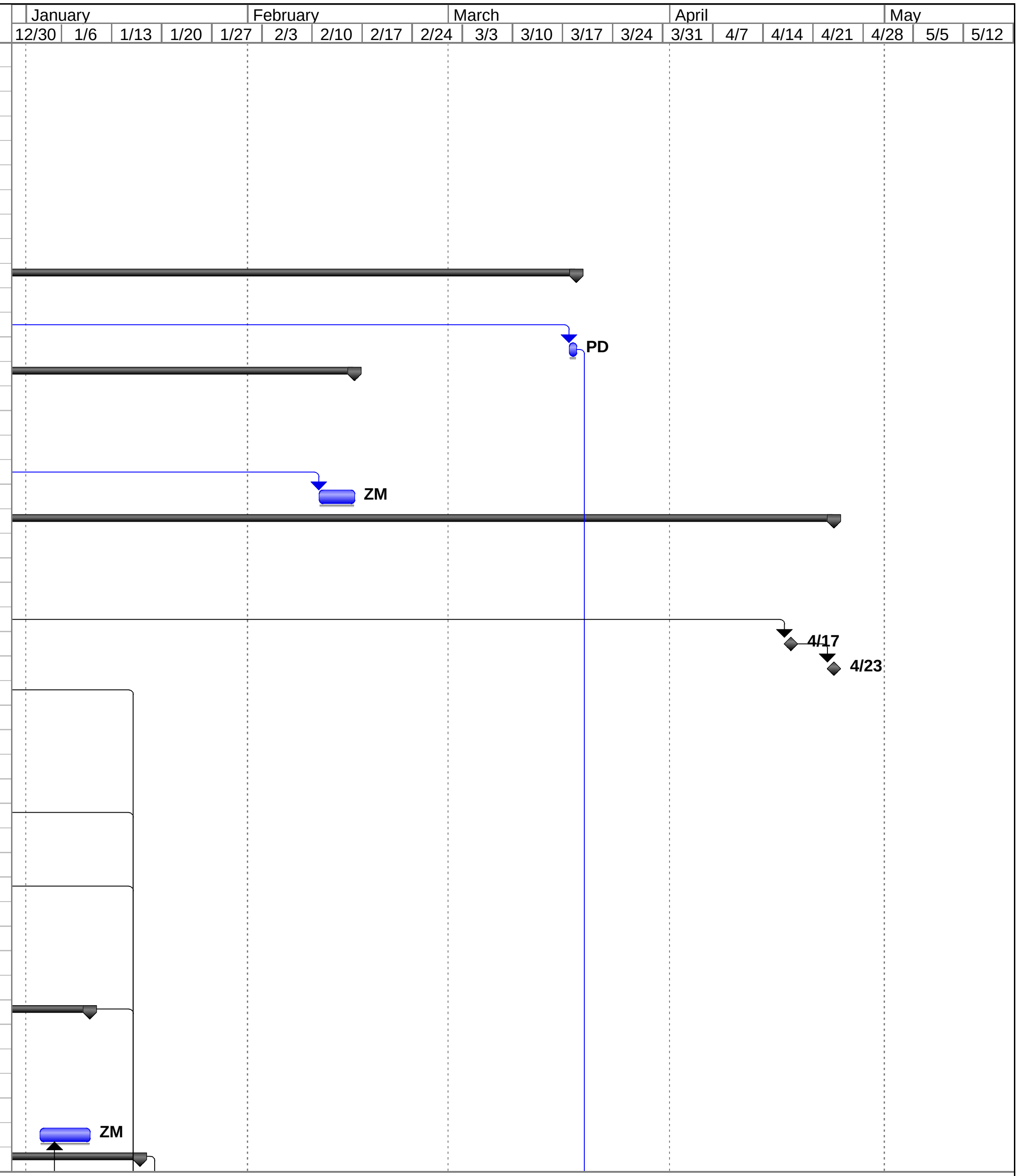
Task		Milestone		External Tasks	
Split		Summary		External Milestone	
Progress		Project Summary		Deadline	

ID	Task Name	Resource Names
1	**Gain understanding of transport systems**	**FO**
2	Meet with Prof. Vuchic	ZM
3	Research on Traffic Organizations in Philadelphia	PD
4	Research on Transport engineering basic concepts	FO
5	Research Distribution Model	ZM
6	**Design Transport System Model**	**FO**
7	Come up with system block diagram	FO
8	Define subsystems	FO
9	Define linkages between subsystems	
10	**Work with Philadelphia Police Dept**	**PD**
11	Establish contact through Prof. Heummeler	PD
12	Meet contact to understand current traffic routing system	PD
13	Meet to discuss implementation ideas	PD
14	**Work with Phillies/Eagles**	**ZM**
15	Establish contact person through Prof. Heummler	ZM
16	Meet with contact person in Phillies/Eagles	ZM
17	Visit stadium to analyse problem (and watch a game)	ZM
18	Review meeting to discuss objectives	ZM
19	Review meeting to obtain feedback	ZM
20	**Complete course requirements**	**FO**
21	Proposal	ZM
22	First presentation	PD
23	1st Project Report	FO
24	Phase 1 Report	ZM
25	Phase 2 Report	PD
26	Demo Day	FO
27	**Develop Football Game Demand Generation Model**	**ZM**
28	Research geographic profile of fans	ZM
29	Profiling of fans in attendance	ZM
30	Repeat attendance (I.e. season ticket holders, etc.)	ZM
31	Produce demand generation model	ZM
32	**Develop Model to Quantify Incentive schemes (Tailgate model)**	**ZM**
33	Produce linitial list of potential incentives	ZM
34	Create model that accounts for Individual preferences	PD
35	**Develop Train transit model**	**PD**
36	Create network model of Stations and lines	PD
37	Program algorithm to collect Schedule/capacity data	PD
38	Connect train transit model to overall geographic model	FO
39	Create Station level model (for exiting)	FO
40	**Develop Bus transit model**	**PD**
41	Collect data about Schedule and capacity	PD
42	Understand scope for additional buses	PD
43	Connect this model into overall geographic model	PD
44	Plug into traffic model	PD
45	Estimate additional emissions impact from this model	ZM
46	**Develop Car transit model**	**ZM**



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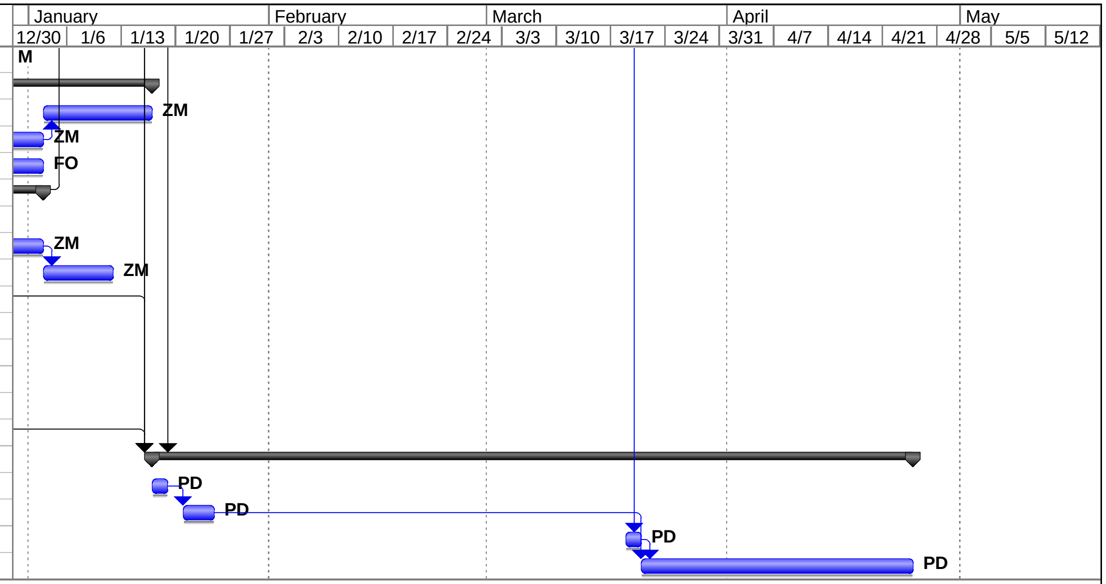
Task		Milestone		External Tasks	
Split		Summary		External Milestone	
Progress		Project Summary		Deadline	

ID	Task Name	Resource Names
47	Conduct research to profile current car uses	ZM
48	**Model road network**	**ZM**
49	Code Macro scale network (highways, general directions, etc.)	ZM
50	Code Micro scale network (parking lot streets, corners, signals)	ZM
51	Create Agent-based traffic model	FO
52	**Estimate emissions**	**ZM**
53	From idling	ZM
54	Per distance	ZM
55	Analyze scope for Pareto improvement in traffic routing	ZM
56	**Integrate subsystems into overall Transit model**	**FO**
57	Model Constraints into the model (e.g. Eagles budget)	FO
58	Understand collaborator constraints (SEPTA/police cooperation, etc.)	FO
59	Build the Distribution model (including current data)	ZM
60	Build the Assignment model (including current data)	FO
61	**Design Feedback loops**	**FO**
64	**Develop Front end for implementation**	**PD**
65	Specify end-user requirements	PD
66	Determine flexibility requirements	PD
67	Determine platform (iPad vs smartphone vs pc?)	PD
68	Design GUI	PD



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