Build a Better Bus Route

New Mexico
Supercomputing Challenge
Final Report
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Team 17
Centennial High School

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Executive Summary:

Las Cruces Public Schools buses use approximately 220,927.5 gallons of gasoline annually. This is negative for our environment because just one gallon of gas burned creates 19 pounds of carbon dioxide in the atmosphere, which can cause all sorts of problems for the environment. Before understanding the environmental effects, we chose this topic when one of

our group members noticed that the bus routes in our district seemed to be random and inefficient. We figured that the bus routes might be using more gasoline than they should be. We decided to create more efficient bus routes for our school, because more efficient bus routes would mean less harmful greenhouse gases being released into the atmosphere. At first, we had decided to reroute all of our school's bus routes to be more efficient, but after attempting to model all these routes and especially after our Project Evaluations, we realized that rerouting all the bus routes involved too many variables and would take too long to model, so we wouldn't be able to finish on time.

We decided to model just one bus route from our school, the route of bus #37. We used NetLogo® for our coding. The first problem we encountered was traffic patterns, stop signs and stoplights, because they were difficult to predict. We attempted to find a way around this through research and through observing the route in person. Our coder looked in the model library for information, then looked in the online library. All this information gave us the direction we needed, so we put the research to work and were able to begin modelling traffic patterns on a very basic level. Our results were inconclusive. Originally, our model was supposed to model a bus route of Centennial High School (bus #37). It would then show how much fuel the buses used, then it will create a new route that saves fuel. However, we are still working on the model, as it doesn't function the way we want it to. The model has many shortcomings, and the results were inconclusive. Our research enabled us to draw a few conclusions despite the model's failures.

INTRODUCTION:

Annually, Las Cruces Public Schools has more bus mileage than anywhere in New Mexico, except Albuquerque Public Schools (NM PED). We first became curious about this when one of our group members noticed that bus routes in Las Cruces seemed to be random and inefficient, and we thought that the bus routes were using way more gas than they should. We decided to reroute our school's bus routes using NetLogo to make them more efficient and conserve more gas. We reasoned that more efficient bus routes would use less gas and release less carbon dioxide into the atmosphere. However, after our Project Evaluations we realized that rerouting every single bus route would take too long and we wouldn't be able to finish it. We decided to reroute just one bus route, bus #37. For our model, we decided to simulate the traffic patterns the bus goes through daily, including stoplights and stop signs. We also had to take afternoon traffic patterns as well as morning traffic patterns into account, and there were also a few variables we didn't expect, which was a minor setback.

DESCRIPTION:

According to the New Mexico Public Education Department of Transportation there are 136 buses in Las Cruces Public Schools that transport 10,058 kids dialy. 2,006,374.2 is the number of miles that the buses in Las Cruces travel annually (NM PED). Because school buses average 9 miles per gallon (DOT “Statistics”, and the number of miles traveled annually is 2,006,374.2, then the 163 school buses in this district use 220,927.5 gallons of gasoline a year. Las Cruces Public Schools spends $3,299,469.84 a year on school buses. This includes repairs, maintenance, and, of course, gasoline (NM PED).

Because of the shocking amount of gasoline used by buses in the Las Cruces Public School system, the main purpose of this project was to reduce the number of gallons of gasoline used by the district. Much of our research showed just how important reducing gasoline is. For example,according to slate.com, each gallon of gas a vehicle burns, it releases 19 pounds of CO2 (carbon dioxide). When gasoline is burned by a vehicle, it creates three times the amount of greenhouse gas. When gasoline makes contact with the air it produces hydrocarbons, and when hydrocarbons burn they break apart and combine with the air, creating a heavier volume of greenhouse gasses than the volume of the original carbon dioxide. This is a concern because, according to National Geographic, CO2 is at the highest level in two million years, and is a major cause of global climate change (Koerth-Baker). Global climate change is defined as a long-term change in the Earth’s climate, or of a region on Earth (Conway).

Additionally, The United States Environmental Protection Agency (“Climate Change Basics”) states that the greenhouse gas CO2 can also be bad for humans’ health and everyday lives. Global climate change could “affect our our water supplies, agriculture, power and transportation systems, the natural environment, and even our own health and safety” (“Climate Change Basics”). The EPA also says that the burning of fossil fuels like gasoline is the main

cause of these problems. In order to reduce the impact of global climate change, humans need to reduce their usage of fossil fuels like gasoline ("Climate Change Basics")

RESULTS:

The program (see Appendix A) is intended to model a bus route of Centennial High School (bus #37). It was intended to then explain how much fuel the buses used, then it will create or run a new route that saves fuel. Presently the model does not meet these goals. Currently the "setup" procedure create a turtle shaped "bus," the "make" button creates the outlines or boundaries of streets, and the "something" button creates the streets themselves by changing the patches. The "car" button creates a fixed number of cars and placed the "bus" on the outskirts of the model. Hitting the "left," "right," or "forward" buttons changes the heading of the bus but not the cars.

Right now the model is inadequate for our solving our problem because we were unable to model the streets or the buses correctly. The model successfully generates different numbers of cars, but they do not move in different routes--they only move in one direction. Also, the bus "turtle" and cars cannot currently be controlled separately. The model does not show the real route or alternate routes, which was the main goal of the project- for the buses to be able to run on different routes, so we we would be able to measure the time it took and the gallons of gas used. The model does not have a monitor showing the amount of CO_2 produced by the bus in a route or per mile. The model also does not take all of the stoplights and stop signs from the real route into account, and the same is true for any potential alternate routes. Overall, all that this current model shows us is the path that "x" number of cars or buses would take in one direction upon creation.

CONCLUSIONS:

It is impossible to draw conclusions from our current model. Though the current model itself is not adequate for data analysis, our research definitely was a start. By researching the average number of miles travelled and, on another website, the average amount of gas used per mile for the average school bus, we were able to determine how many gallons of gas each bus uses. We were also able to determine how much gas all of the school buses in our district used. This information led us to the conclusion that something definitely needed to be done to reduce the amount of mileage in our district. While we never got into direct contact with any of the Public Education Department of Transportation (none of our emails, phone calls or voice messages were ever answered) for our district, it is a happy coincidence that shortly before we submitted this final report, the bus route we studied was combined with another in the district, thus reducing the number of buses in the district by one. While one may seem a small number, we take into account the fact that one pound of gasoline burned equals nineteen pounds of carbon dioxide. So one bus is a good start for our district and for the environment, because one gallon less equals nineteen less pounds of carbon dioxide in the atmosphere.
Interpret your results based on the facts and evidence.

RECOMMENDATIONS:

Next year we would definitely like to take a class to learn more about programming. We would also focus more on promoting teamwork and eliminating animosity, improving communications between team members, designating equal workloads for everyone on the team, making sure every single team member knew how to program in case our main coder was sick or some unforeseen setback came up. As far as furthering this project goes, we would like to complete a more accurate model--to create a program with several different “setups” of

various different routes for our bus to take and the ability to monitor these routes for several variables, like mileage, gallons of gas used, or CO2 produced. We would also like to add sliders to control the number of cars on the streets. We would also like to continue to pursue information from the district's transportation department.

MOST SIGNIFICANT ACHIEVEMENT:

Our most significant achievement would be finding any valid facts on our project, including an obscure site with statistics that we used. The research was more difficult because we did not have the cooperation or assistance of LCPS Dept. of Transportation. However, considering all these obstacles, we managed to find lots of information on what we needed to know, so we consider that our most significant achievement.

ACKNOWLEDGEMENTS:

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APPENDIX A
(CODE)

```
to Up  ;; Movement keys
  ask turtles [forward 1]
end
to Start ; This should be the first button you press
clear-all
  set-default-shape turtles "turtle"
  create-turtles 1
  ask turtles [set heading 360
  ]
  ask turtles [set color red]

end
to herp;; manual draw
  ask turtles [pen-down]
end
to Road ;; Second button you press
  ask turtles [pen-down]
  ask turtles [forward 100]
  ask turtles [left 90]
  ask turtles [pen-up]
  ask turtles [forward 4]
  ask turtles [pen-down]
  ask turtles [right 90]
  ask turtles [forward 105]
  ask turtles [left 90]
  ask turtles [forward 99]
  ask turtles [right 90]
  ask turtles [forward 4]
  ask turtles [left 90]
  ask turtles [forward 105]
  ask turtles [right 90]
  ask turtles [forward 101]
  ask turtles [left 90]
  ask turtles [forward 4]
  ask turtles [right 90]
  ask turtles [forward 105]
  ask turtles [right 90]
  ask turtles [forward 26]
  ask turtles [left 90]
  ask turtles [forward 105]
  ask turtles [right 90]
  ask turtles [forward 4]
  ask turtles [right 90]
```

```
  ask turtles [forward 105]
  ask turtles [pen-up]




end
to something ;; For the Roads
  if (pxcor < 16) and (pxcor > 12) [ set pcolor grey]
  if (pycor < -1) and (pycor > -5) [ set pcolor grey]
  if (pxcor <  0) and (pxcor > -4) [ set pcolor grey]
  if (pxcor <  -15) and (pxcor > -1) [ set pcolor grey]
  if (pxcor < -10) and (pxcor > -14) [set pcolor grey]
end
 to car

   set-default-shape turtles "car"
   ask turtles [set color red]
   create-turtles 1

   [set heading 90]
   ask turtles [back 3 right 90 forward 3 left 90]

              ask turtles [forward 1]
              wait 1
              ask turtles [forward 1]
              wait 1
              ask turtles [forward 1]
              wait 1
              ask turtles [forward 1]
              ask turtles [forward 1]
              wait 1
              ask turtles [forward 1]
              wait 1
              ask turtles [forward 1]
              wait 1
              ask turtles [forward 1]
              ask turtles [forward 1]
              wait 1
              ask turtles [forward 1]
              wait 1
              ask turtles [forward 1]
              wait 1
              ask turtles [forward 1]
              ask turtles [forward 1]
              wait 1
              ask turtles [forward 1]
              wait 1
              ask turtles [forward 1]
              wait 1
              ask turtles [forward 1]
              wait 1
              ask turtles [forward 1]
              wait 1
              ask turtles [right 90]
              wait 1
              ask turtles [forward 1]
              wait 1
```

```
        ask turtles [forward 1]
        wait 1
        ask turtles [forward 1]
        wait 1
        ask turtles [forward 1]
        ask turtles [left 90]
        wait 1
        ask turtles [forward 1]
        wait 2
        ask turtles [right 90]
        ask turtles [forward 1]
        wait 1
        ask turtles [forward 1]
        wait 1
        ask turtles [forward 1]
        wait 1
        ask turtles [forward 1]
        ask turtles [forward 1]
        wait 1
        ask turtles [forward 1]
        wait 1
        ask turtles [forward 1]
        wait 1
        ask turtles [forward 1]
        wait 1
        ask turtles [forward 1]
        wait 1
        ask turtles [right 90]
        wait 1
        ask turtles [forward 1]
        wait 1
        ask turtles [forward 1]
        wait 1
        ask turtles [forward 1]
        wait 1
        ask turtles [forward 1]
end

        ;; this will model a bus route of Centennial and explain how much fuel the buses then it will make a new route saving fuel
```