Final Report

School Name: **Melrose Middle School.**

Team Number: **Melrose Mid 1.**

Title: **Our Dirt Road Anthem.**

Area of Science: **Engineering.**

Team Members:

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Executive Summary:

Our project is about dirt roads and how important they are to rural areas. Specifically, it deals with showing how unpaved roads are affected by the weather and are then in need of maintenance by road graders to manage wet dirt roads with ruts that make them less passable to vehicles.

Our model will show a small area of Melrose where there are some of our main dirt roads that are bad, medium, and good quality. Our model will also show the road grader, going to fix the roads that have been rained on. The houses with the bad roads will have complaints, and turn different colors. Once the houses with dirt roads are fixed, they will turn back to their original color.

Some of the most important variables that our model deals with are the size of our mapped area, the location of roads, the location of houses, the types of roads (which are highways, improved caliches, improved dirt and dirt) and also the road conditions. We also have variables about the weather. These include the amount of rainfall, where it falls, and how quickly it evaporates. Lastly, our model includes the road grader speed, the number of road graders, and lastly the measure or residents happiness from roads.

The reason we chose this project is because we have experience with dirt roads and when they are wet. We hope to make it easier to make good roads around our area, by helping the road maintainer crews have a better system of deciding what roads to service, and how to schedule this action in an improved and more timely this way. This will make life easier for the road crews, and improve the satisfaction that local residents have with their roads.

Plan for solving the problem and representing it computationally:

Our project took several steps to complete. After we came up with our idea, it started with research and performing several interviews with residents and workers who deal with this topic. Our project used LOTS of practical information that we got from interviews with those working with this topic. We asked professionals about how road maintenance works, and how road graders can improve road conditions. Our families helped us see how roads affect local residents. (Especially after a couple of us got 'rained in' for several days last fall!) Also, we got guidance on being able to show how different weather conditions can affect dirt roads. This gave us the basic information for us to be able to plan our model, determine its most important variables, and to figure out what we wanted the model to be able to show.

Next we worked to create a computer model. This project required a lot of work because we needed to use the tons of information we had found. We wanted our model to include these basic variables: **a)** how much work road graders can do in a day, **b)** how many dirt roads are in an average area**, c)** what kind of condition these roads are in initially, **d)** how these roads are affected by different types of weather, **e)** how many maintainers are available for an area, and **f)** how this information allowed us to come up with algorithms on how to have the model make decisions.

Method:

We decided our model will show an area that represents our local school bus routes. This is a good size so that we will have a manageable area and be a location we are familiar with

so that we can discuss it easily. We will have enough families on roads that we will know about the weather on the roads.

The following are ways that the different patches of our NetLogo model represent our map variables:

Pastures- On our set up we have the pasture as green. When it rains it turns blue then it evaporates and turns back to green

Paved highways-The paved highways are uninfected by the rain. They do not need assistance from the road graters. They are represented as black.

3 types of dirt roads- improved caliche with a light tan color, improved dirt road with a medium brown color, and normal dirt roads with a dark brown color. Caliche is a sedimentary rock, a hardened natural cement of calcium carbonate that binds other materials and helps to make an improved dirt road.

3 elevations- 1 is where all the rain slides of the road. 0 is where the some of the rain slides off the road. -1 is where the road collects rain in low spots. This information is stored as a patch variable and does not affect colors.

House- are originally light pink and when a road is muddy the house turns red. So that the road grater will know to go fix the road. When the road is fixed the house turns back to light pink.

Rains storms are created randomly with random sizes. They show us as blue patches on the map until they evaporate.

Rain effects the roads and the roads turn orange. Then the road grader comes and fixes the road.   This improves the happiness level of nearby residents, and house colors change accordingly.

When it rains it rains in patches occasionally sometimes it rains a lot and sometimes it rains just a little bit. After it rains the rain evaporates then the roads are just muddy then the road grater has to come to fix it.

Road-grader - When it rains the rain evaporates then the road turns orange, so that the road grater will come and fix the road. After the road is fixed it turns back to its original color.

Road-grader – We also have the road grader controls built in the system, so that way we can control the road grader and where it needs to go. This lets us compare how quickly a person can make decisions compared to the computer.

Expected results and usefulness:

We hope to come up with better ways of road maintenance. This will help make them smoother and more manageable for people to travel on to get to their houses or jobs.

We got the county to look over our system, so we can see how long it takes to get an area done and the roads fixed. Who knows? Maybe they will even be able to use it!

Also, it might be possible to use a similar system to control snow plows and salt truckers on icy highways.

Validation and Verification:

Our group worked with Wendell Belcher, a local retired road maintenance supervisor. We also interviewed our county road department to see how many dirt roads they have to manage, how long it takes to fix different types of roads.

Citations of Research:

1- Interview with, Wendell Belcher, retired road construction worker.

2- Curry County Road Department statistics and data.

3- "How to maintain a dirt road", by Marjorie Burris, Back woods Home magazines, 2000.

4- "Road Maintenance on your dirt road" Hollis Walker, Grit Rural American Know-How 2016.

5- Research report: A Critical Review of Innovative Rural Road Construction, Published by the NRRDA, 2005.

SOURCE CODE:

```
patches-own [ elevation originalcolor surface condition]

globals [raindate rutsx rutsy totaldry]

breed [ roadgraders  roadgrader]

breed [ clouds cloud ]

breed [ houses house ]


to setup

   clear-all

   reset-ticks

   ask patches [set pcolor 57  set originalcolor 57 ]

   highways

   dirtroads

   buildhouses


end


to highways

   crt 1

   ask turtles [setxy -16 -7 set originalcolor black

     set heading 90

     repeat 33 [set pcolor black set originalcolor black fd 1]

     setxy -1 -6  set heading 0

     repeat 23 [set pcolor black set originalcolor black fd 1]

     set color black set originalcolor black

     setxy 3 -7  set heading 180

     repeat 10  [set pcolor black set originalcolor black fd 1]   die

   ]

end
```

```
to dirtroads

 crt 1

 ask turtles [ setxy 13 -8 set pcolor  brown set originalcolor brown

    setxy -1 7   set heading 270   repeat 15 [fd 1 set pcolor  brown set originalcolor brown set surface random 2 - 1
set elevation random 2 - 1]

    setxy -1 13  set heading 270   repeat 11 [fd 1 set pcolor  brown set originalcolor brown set surface random 2 - 1
set elevation random 2 - 1]

       rt 90 repeat 3 [fd 1 set pcolor  brown set originalcolor brown set surface random 2 - 1 set elevation random
2 - 1]

    setxy -7 13  set heading 180   repeat 25 [fd 1 set pcolor  brown set originalcolor brown set surface random 2 - 1
set elevation random 2 - 1]

       lt 90 repeat 9 [fd 1 set pcolor brown set originalcolor brown set surface random 2 - 1 set elevation random 2
- 1]

    setxy -1 -7  set heading 180   repeat 5  [fd 1 set pcolor  brown set originalcolor brown set surface random 2 - 1
set elevation random 2 - 1]

    setxy -1 10  set heading 90    repeat 17 [fd 1 set pcolor  brown set originalcolor brown set surface random 2 - 1
set elevation random 2 - 1]

    setxy 9 -16  set heading 180   repeat 23 [fd 1 set pcolor  brown set originalcolor brown set surface random 2 - 1
set elevation random 2 - 1]

    setxy -1 0   set heading 90    repeat 17 [fd 1 set pcolor  brown set originalcolor brown set surface random 2 - 1
set elevation random 2 - 1]

    setxy -7 -7  set pcolor 0  set originalcolor 0    setxy -7 -6  set originalcolor brown set surface random 2 - 1  set
elevation random 2 - 1

       setxy -7 -7  set originalcolor black   setxy 9 -6  set originalcolor brown set surface random 2 - 1 set elevation
random 2 - 1

       setxy 2 -6  set originalcolor black   die

 ]

   ask patch -1 -16 [set pcolor 57 set originalcolor 57]

   ask patch 9 -16  [set pcolor 57 set originalcolor 57]

 setsurface

end
```

```
to setsurface

   ask patches [ if pxcor = -7 and (pycor > -7 and pycor < 8)  [set pcolor 36 set originalcolor 36 set surface 1 set
elevation random 2 - 1]]

   ask patches [ if pycor = 7 and (pxcor > -7 and pxcor < -1)  [set pcolor 36 set originalcolor 36 set surface 1 set
elevation random 2 - 1]]

   ask patches [ if pxcor = -1 and (pycor > -13 and pycor < -7) [set pcolor 36 set originalcolor 36 set surface 1 set
elevation random 2 - 1]]

   ask patches [ if pxcor = 9 and (pycor > -7 and pycor < 10)  [set pcolor 36 set originalcolor 36 set surface 1 set
elevation random 2 - 1]]


   ask patches [ if pycor = 13 and (pxcor > -13 and pxcor < -6)  [set pcolor 34 set originalcolor 34 set surface -1 set
elevation random 2 - 1]]

   ask patches [ if pxcor = -7 and (pycor > -12 and pycor < -7)  [set pcolor 34 set originalcolor 34 set surface -1 set
elevation random 2 - 1]]

   ask patches [ if pycor = -12 and (pxcor < -1 and pxcor > -8)  [set pcolor 34 set originalcolor 34 set surface -1 set
elevation random 2 - 1]]

   ask patches [ if pxcor = -12 and (pycor > 12 and pycor < 17)  [set pcolor 34 set originalcolor 34 set surface -1 set
elevation random 2 - 1]]

end




to buildhouses

   crt 1 [setxy -13 16 set color 19  set originalcolor 19   set breed houses set shape "square"]

   crt 1 [setxy -3 8  set color 19   set originalcolor 19   set breed houses set shape "square"]

   crt 1 [setxy -8 1 set color 19    set originalcolor 19   set breed houses set shape "square"]

   crt 1 [setxy -8 -1 set color 19  set originalcolor 19   set breed houses set shape "square"]

   crt 1 [setxy -8 -13 set color 19  set originalcolor 19   set breed houses set shape "square"]

   crt 1 [setxy -1 -13 set color 19  set originalcolor 19   set breed houses set shape "square"]

   crt 1 [setxy 13 -9 set color 19   set originalcolor 19   set breed houses set shape "square"]

   crt 1 [setxy 10 2  set color 19  set originalcolor 19    set breed houses set shape "square"]

   crt 1 [setxy 15 11  set color 19  set originalcolor 19   set breed houses set shape "square"]
```

```netlogo
  crt 1 [setxy 4 11  set color 19   set originalcolor 19   set breed houses set shape "square"]

  crt 1 [setxy 2 -6 set color 44    set originalcolor 44   set breed houses set shape "square"]

  crt 1 [set breed roadgraders set shape "arrow" set color 46 set heading 180  set size 1 ]


end



to time

  if random 365 < (monthlystorms * 12) [rain]

  maintainer

  evaporate

  complaints

  ask houses [ if not any? patches in-radius 4 with [pcolor = 24 ]  [ set pcolor originalcolor ]  ]

  tick
end



to rain

  create-turtles 1   [set breed clouds set color 5 set shape "circle" setxy random-xcor random-ycor]

  ask clouds  [ set pcolor 95

    repeat random (30 + 10) [ fd 1 rt random 180 lt random 180 set pcolor 95 ]  die]

  mudbog
end



to mudbog

  ask patches [ if pcolor = 95 and originalcolor = brown [ if surface = -1 and random 100 > 10 [ set pcolor 24 set rutsx pxcor set rutsy pycor ]]

        if pcolor = 95 and originalcolor = brown [ if surface = 0 and random 100 > 60 [ set pcolor 24 set rutsx pxcor set rutsy pycor ]]
```

```
        if pcolor = 95 and originalcolor = brown [ if surface = 1 and random 100 > 90 [ set pcolor 24 set rutsx
pxcor set rutsy pycor ]]


        if pcolor = 95 and originalcolor = brown [ if elevation = -1 and random 100 > 10 [ set pcolor 24 set rutsx
pxcor set rutsy pycor ]]

        if pcolor = 95 and originalcolor = brown [ if elevation = 0 and random 100 > 60 [ set pcolor 24 set rutsx
pxcor set rutsy pycor ]]

        if pcolor = 95 and originalcolor = brown [ if elevation = 1 and random 100 > 90 [ set pcolor 24 set rutsx
pxcor set rutsy pycor ]]

   ]
end




to evaporate

  if ticks > (raindate + evaperationtime + random evaperationtime) [ask patches [ if pcolor > 24 [set pcolor
originalcolor ]]]

end




to maintainer

;;   if any? patches with [pcolor = 24] [ask roadgraders [facexy rutsx rutsy  repeat 4 [fd 1 set pcolor originalcolor]]]

end




to complaints

   ask patches [ if pcolor = 24  [ask patches in-radius 6 [if originalcolor = 19 [ if pcolor > 13 [set pcolor (pcolor -
1)]]]]]

end
```