Sun Talkers

New Mexico Adventures in
Super Computing Challenge
Final Report
April 6, 2005

Team Number 036
Melrose High School

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Executive Summary

Bringing the challenges of math related science and history together through the process of computing, has helped us form new theories that have opened our minds to think above and beyond. Our project is to analyze the process of communicating by using light from the sun, as if we didn't have the technology that we use today. The heliograph is a mirrored communication device for sending messages in Morse Code by flashing reflected sunrays to another location up to 50 miles away.

We chose this project because New Mexico and Arizona are well known for their forts and frontier battles that affected the outcome of our country. Conveying messages in this form quite possibly could have changed history. If you think back to the time of cowboys and Indians, you will recall where they had to travel by horse to warn the next fort of danger. Before the back up soldiers could even arrive, the Indians had cleared out and the fort was abandoned, and many had lost their lives. If only, the soldiers on the frontier would have used a heliograph and told the forts 50 miles away of the danger, they could have prepared and been ready for the attacks. Heliographs also could have been beneficial for eastern parts of the United States.

We are building an actual heliograph so that we can test how well it works. By using atlases and the Internet, we have pin pointed higher elevated mountain peaks and are charting them through supercomputing techniques. We are trying to create a path, first across New Mexico and Arizona, and possibly across the entire nation, that the heliograph signals could be transmitted on.

There are many variables that we have to determine in order to complete this project. The curvature of the earth plays an effect when going from one peak to another. The higher the heliograph is, the further it can send a signal. Weather also plays an effect, due to line of sight being blocked by clouds, dust storms, and other causes. There are some dilemmas that we have encountered in our math problems and we have a student at ENMU, who is majoring in Math, has assisted us with the formulas.

In conclusion this project has proven our theory, that it could have been possible to use the heliograph communication signaling to transmit messages. Furthermore, it is plausible that it might have changed the outcome of certain wars in previous eras. Super Computing has helped us to organize our data and draw reasonable conclusions. It has also helped us create graphs of the mountain peaks and their heights to determine the line of sight distance, so that we could create a network channel of heliograph communication. The simple creation of a heliograph could have possibly formed the "Sun Talkers" of the past.

Sun Talkers

Our super-computing project is communication through the use of heliographs. A heliograph is a mirrored communication device for sending messages in Morse code by flashing reflected the sun's rays to a distant station. The heliograph is a simple but highly effective instrument used for optical communication over 50 miles or more in the 19^{th} century. Its major uses were for military and survey work. It was still in serious use until 1935, for example by Glubb Pasha's Arab Legion in Palestine. Conveying messages in this form could have changed history by the Apaches, by the British in Colonial wars, and by many others.

We want to calculate how the curvature of the earth and the heights of various mountain peaks will affect the line of sight view to transmit these messages throughout the nation. We will include alternate paths for weather variations. We want to calculate the most efficient path among alternate routes so that our heliograph can transmit messages in a full path from coast to coast of the United States of America. We are already planning a path across our state and hopefully others later on. The alternate routing is used because anything from dust storms to rain can throw off the message results from their intended targets. We are also discussing using a magnesium flare so that messages can be sent at night as well as day so that daylight would not be a factor.

We have researched the history and use of the heliograph in the past. Its major uses were for military and survey work. It was used during westward expansion amongst white settlers in their forts to protect against Indians. The signals symbolized that the Indians were coming and they could prepare themselves for battles.

It was also used during World War I as a warning of approaching enemy troops. This proves that heliographs do work and are able to send long-range signals. Most signals can be transmitted up to 50 miles away. Heliographs were beneficial during this time period, because they could be certain the messages were going to get through, as telegraph wires could be cut.

The use of the heliograph could have been expanded with people looking into maps and other geographical sources for information on where to place their heliographs so that they could send messages across the United States. If researched properly and planned, heliographs could still be used today.

The heliograph's usage could have been expanded; however there are reasons that it wasn't. The basic manpower that it would have taken to do set up posts all across the nation would have put a strain on those operating it. It would have taken about ten men per post, and there weren't enough men to go around since many already had a position in the military and were needed for fighting.

If it would have been used, for example, in the War of 1812 it could have changed the outcome. If posts were set up along the East Coast, we could have known in advance of invading British troops and withstood their attacks. This could have been used to help us win the Revolutionary War more quickly in just the same ways. It could have been a useful tool if it had been used more, but the men needed and the number of posts needed was simply too much for them to work with.

In our work to solve this problem we did some basic things:

- Math equations to determine lines of sight
- Made a model of a heliograph to show how it operates

- Pick locations for possible heliograph sites
- Determine the probability of being able to send the signal through a certain path
- Figuring the costs and manpower needed

First of all, we have been using geometric formulas to calculate the line of sight view between two mountain peaks. These are shown in Appendix B. This is difficult and requires complex calculations, due to the earth's curved surface. We are also calculating how far light can reach from the top of the peaks based on their various heights. A math major from a local university is helping us with the more complicated formulas that we come across.

We are in the process of constructing an actual heliograph to determine how it is put together and how it works. We are planning to test our model out and establish how far it can actually send the messages. We are building this, because we believe that it would be beneficial for us to actually view how this mechanism operates, so we can better understand our project. This way we can know firsthand whether this would work or not.

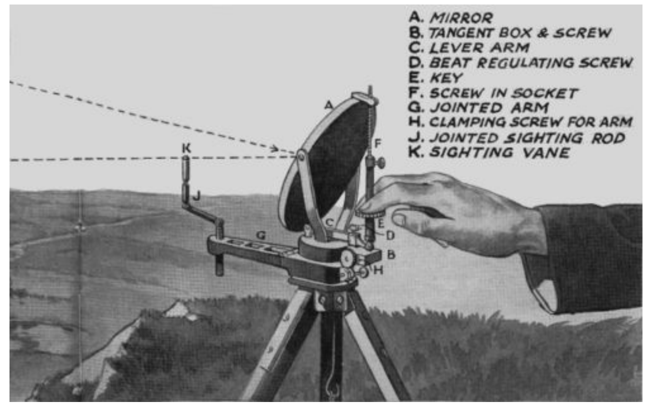
We have used atlases and maps to find the peaks that would be the most efficient to use in the areas around us. Also we have used the Internet as a reference for finding ideal mountains for our purpose. So far, we have composed a list of various mountain peaks in New Mexico and Arizona that we could use for our project. We are also looking into the previous locations of the heliographs in this area, and we might use those same peaks.

Using the Monte Carlo Simulation we are working on figuring out the probability of being able to send messages along certain paths. We are going to have several paths going to the same location in case the probability of transmitting messages through some of our paths is very low.

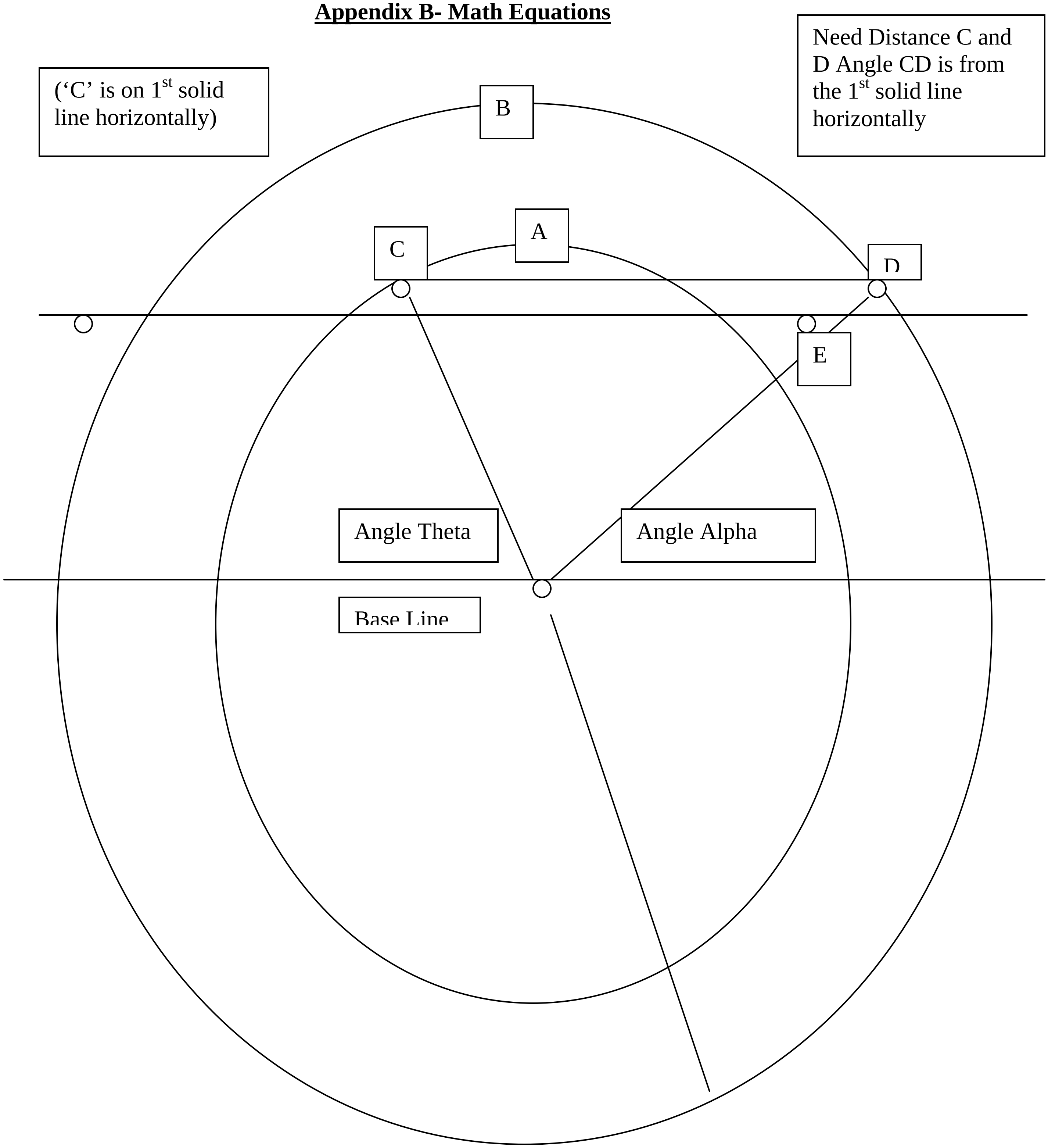
Our project is larger than we expected, and is very extensive as to the broad spectrum of the mountain ranges. The geometry involved is very detailed when discussing the curvature of the earth, and how it isn't perfectly spherical. However, we had a great team that worked together in terms of the actual building of our prototypes and our written structures. We have all experienced cooperative learning through the entire process of Supercomputing. We have benefited from our project, while in the classroom, being more confident with our ability to work through problems with our minds. Also by working together as a group and cooperating with each other, we are striving to achieve a common goal.

We would like to thank Alan Daugherty and Rebecca Raulie for their time and help with our project. Both of them have volunteered numerous hours and have purchased any supplies we needed. We appreciate their hard work and dedication. We would also like to thank Joe and D'Layna Reed for their help with our calculations. We also appreciate all the help from the various scientists and judges who have helped us throughout this entire process.

<u>**Appendix A – Pictures**</u>



Appendix B- Math Equations



CD = the square root of [$A^2 + B^2 - 2AB \cos(\text{Theta} - \text{Alpha})$]

Sin(Theta – Alpha)/CD = Sin(D)/A — This finds angle D

180 – Alpha = Angle E — Corresponding Angles

Angle DCE = 180 – (Angle D + Angle E)