Varsha Alladi, Lilian Amer, Luciana Piarulli, Lauren Kim

Problem of the Week No. 1

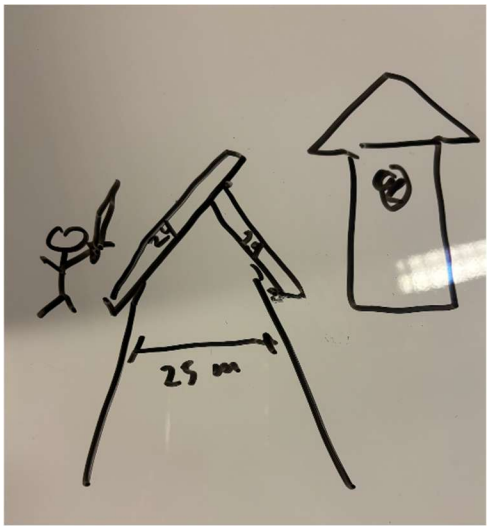
Math Modeling

Ms. Burns

8/29/24

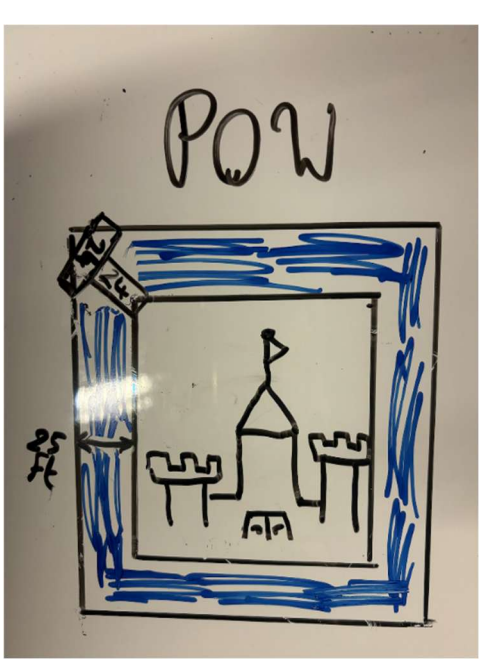
The problem was that Rapunzel was locked up in a tower surrounded by a moat (again) by her witch of a stepmother, but because Rider had decided to cut off all her hair (to the point she can't even get it properly cut by a hairstylist later), she had no way of getting out. The moat is square-shaped, 25-feet across at all sides with no drawbridge and filled with crocodiles that eat anyone that enters the water. All Flynn can use is two beams of wood, each 24-feet long by 9 inches wide, that can't be joined or lengthened together. Rapunzel is only able to give a few hints to help him rescue her (probably because she was so mad about her hair being cut off so short). We were tasked with finding the hints that Rapunzel could've given, and ultimately solving the problem.

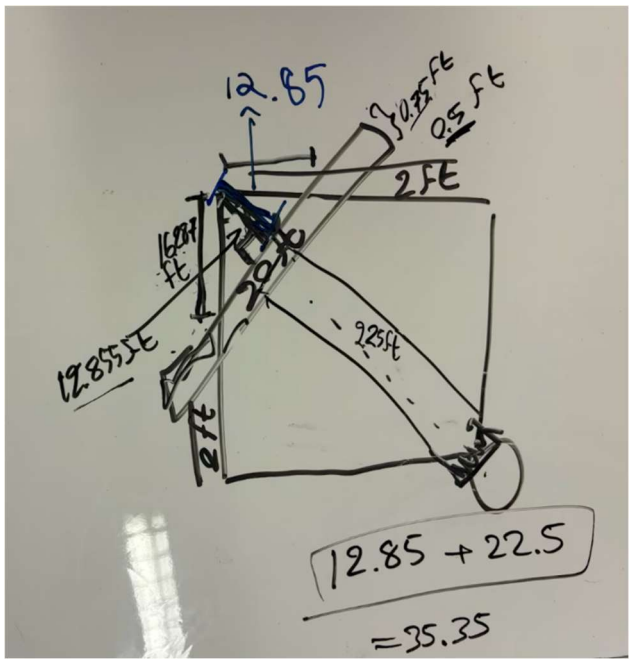
After reading about the problem, we began to think of ways in which we could rearrange the wooden planks to create some sort of bridge. In the beginning, we thought that the planks could be placed in the formation where one plank leans on the other forming a triangle. The image below is our original idea.



As we began to explore this idea further, we realized that there were some problems with this idea. Firstly, we realized that although the boards connect with each other at the tip, the design is not strong enough for Ryder to cross over. The boards only rest against each other, and once Ryder begins walking on the board, it would displace the adjacent board.

After concluding that this idea is not viable, we began to think of other ideas, which is when we came to our answer. Our solution was to place one plank diagonally across the corner of the moat then place another plank on top of the moat to reach the tower. Below is the image of our conclusion.





We figured that if Flynn Ryder took one of the planks and placed it diagonally across one of the corners of the moat, then he could walk across and place the second plank perpendicular to the first. So, one edge of the second plank rests on the first and the other lands on the shore of the castle. The first plank should be 12.85 feet from the outside shore, so that the plank covers enough land to be stable and should have two feet on each side extra for stability, so Flynn doesn't have to fall. We found this number by using the Pythagorean theorem, assuming Flynn Rider placed the first plank perpendicular to the inside corner, meaning the angle would be 90 degrees. Since the two side lengths of a corner are 25 & 25, the hypotenuse to the other side of the moat would be $25\sqrt{2}$, or 35.35 feet. The plank would overlap with the first one by at least half a foot and overlap with the shore on the other side by at least one foot to be stable. This would give Flynn more than enough space to walk on the connecting boards and then to the castle, saving his princess (yet again).

In case this problem was too easy for you, here is an extension question we made:

After Rapunzel escaped from the tower, the evil witch wanted to make sure that once she captures Rapunzel once more, she will be stuck in the tower for eternity. The witch magically changed the shape of the moat into a circle, but also left something else behind. The diameter of the moat is the same as it was before (25 ft), and the castle is about 50 feet tall. If Rapunzel's hair was about 50.5 feet long and reached the edge of the moat from the top of the castle, how long should the new object be to make it across the moat?

Answer: at least 5.5 feet

We thought the problem was fun, and a good team bonding experience. We hope that you get to enjoy this problem as much as we did, and feel free to let us know any other solutions you would have come up with!