

**February 25, 1999**

Upon arriving today, Dan had an idea for a change he wanted to make on the 2-D funnel experiment. Actually, he wanted to make a very big change. He wanted to make an almost entirely new 2-D funnel, with the following specifications: The funnel had to have the same containment area as the old one, the slope of the funnel must be the same, and there must be enough room at the bottom to hold the particles. Also, the 2-D funnel was shaped somewhat like an hourglass so that after the particles fell out of the funnel, the entire assembly could be swiveled upside down so the particles would return to the funnel. The new 2-D funnel had to keep this same design. The entire new funnel had to be housed within the same two plates of Plexiglas that the old one was in, so the width and height of the funnel had certain constraints. Other than that, I was free to have the new funnel look any way I wanted it to, just as long as it had the same area and slope as the old one.

The purpose for this change was that Dan wanted to make the 2-D funnel more similar to the new 3-D funnel that I had also helped to build earlier. The new 3-D funnel had a motor that pulled it up at a uniform rate so that as the pile formed below, the distance between the mouth of the funnel and the tip of the pile could be kept constant. The reason for this is that he wanted the potential energy of each particle to be the same as it reached the top of the pile, and the amount of potential energy each particle had was determined by the distance it had to fall through before it reached the pile. In the 2-D funnel, as the pile formed, the mouth of the funnel was at a fixed position above the pile so that as the pile grew, the distance between the funnel and the tip of the pile decreased. Particles were forming the pile with more energy at the beginning, and less at the end. Therefore, he wanted the funnel to be able to slide upwards. To do this, the funnel had to be movable. Also, he wanted to make a 2-D cylinder (analogous to the 3-D cylinder, where particles were uniformly rained out to form the pile). We had come up with the idea earlier that we could make a slot within the piece of Plexiglas that was sandwiched between the two larger Plexiglas plates, and within this slot, we could put in a removable funnel. Building the cylinder would be a bit trickier, since we would have to figure out how to make the particles rain down uniformly from a cavity within the Plexiglas plates.

I was given the task of designing the new 2-D funnel according to the specifications outlined before, and if there was time today, he would get the Plexiglas cut so that we could start building the new funnel. I found a real application for the precalculus I learned last year. I had a chance to work with trigonometry (this would help me to figure out the length of the sides of the funnel in order to keep the same slope angle) and quadratic equations. It was a good thing I always keep my TI-83 with me, because today, it really came in handy.

It didn't take too long to get the measurements for the size and shape of the funnel that I needed. However, since we had spent a lot of time planning how we would build this new funnel, we didn't have much time at the end of the afternoon to actually find the Plexiglas and get it cut.

**March 4, 1999**

Dan had already gotten the Plexiglas cut, and the 2-D funnel had been fully built. My sketch of the 2-D funnel had not been done to scale since its shape and size were unknown when I made the sketch. After I found the measurements for the sides, top, and mouth of the funnel, I had an idea of how the funnel would look, and when I saw the new 2-D funnel, it looked very similar to how I had imagined it would look. The funnel was beautiful—it was the first experiment I had completely designed. It was removable from the Plexiglas assembly, so when the cylinder got built, it could fit within the slot where the funnel was sitting in now.

Dan had figured out a way to have the particles rain down uniformly from the 2-D cylinder, but he hadn't found the materials needed to build the cylinder. He had already designed the cylinder, so we had an idea of what we needed to look for. We spent the first half of the afternoon looking for materials, then during most of the second half, Dan had to leave to attend a meeting. I had the opportunity to talk with the grad students about progress they had made with their research during that time, and also, we had a small conference where each grad student gave a short six-minute presentation on their research to prepare for a conference they would be attending in Atlanta later this month.

**March 11, 1999**

Mentorship was cancelled today because Special Projects Week had begun.

**March 18, 1999**

Mentorship was cancelled again today because we had a Monday schedule today, since students were not able to attend Mentorship without missing their afternoon classes.

**March 25, 1999**

I had to miss this visit to Mentorship because I was attending a 4-day visit to Duke to participate in a scholarship competition.

**April 1, 1999**

This has been my first Mentorship visit in an entire month. When I returned to lab, lots of new experiments had already been set up, so Dan spent most of today explaining the purpose of those experiments. One of the new ones was a 2-D turntable that was tilted at an angle from the horizontal. It was packed to such a high degree that stress chains could be seen all the time because the beads were

compacted together so tightly. The 2-D cylinder had finally been built, but no experiments had been done using either the cylinder or the funnel yet. Dan showed me some graphs he had made from the new 3-D funnel. For the rest of the day we ran the 2D turntable experiment three times (this turntable was horizontal and the beads still had some room to move); it took thirty minutes to record data for each trial because the turntable rotated so slowly.

### **April 15, 1999**

This day was primarily spent in preparation for the Research Symposium. There were a lot of experiments I had done this year, but I could only explain as much of it as would fill ten minutes' worth of presentation time. It was quite disheartening to know I only had ten minutes in which to condense an entire year's worth of work, so we decided to present only the research I had done with 2-D and 3-D funnels and cylinders. We decided that explaining other things I learned, such as mathematical techniques I learned to analyze stress distributions in a material with a uniform distribution of stress (which does not include granular materials), could not be covered in ten minutes. I also had to leave out graphs of the force on the base of pile at various distances away from the center of the base over time, although the graphs were quite simple, and I decided not to explain how the force was actually measured at the base because I would then have to explain how the capacitance sensor worked, and that would make my presentation longer than ten minutes.

We took a look at some slides that Dan had used when he gave his presentation at the American Physical Society meeting in Atlanta last month. There were pictures of experiments that had been done before this year, a slide with the complete definition of a granular material, and lots and lots of graphs. I picked the ones I thought would help me to most easily and thoroughly explain what I had done in the lab so far this year. Dan had to edit the files from which the slides were made so that unnecessary information could be removed, and then he had to print the file onto transparencies so I didn't have to use a slide projector. We didn't make any transparencies today because we were in the process of completing a new run of the 2-D funnel experiment, and we wanted to add on this most recent data to the graphs we already had. After new graphs had been made, I might want to use them in my presentation, so we decided to make transparencies next time.

### **April 22, 1999**

Today was the day that the NCSSM film crew accompanied me over to the lab to interview both Dr. Behringer and me, and to tape examples of my work there. Upon arriving, I found Dan and he got a parking pass for the film crew. We then found Dr. Behringer and we showed the film crew around the lab so they could see which experiments they might like to film. The experiment that was picked was one that I had not worked much on, but was similar enough to an experiment I had been working with that I was

prepared to explain the purpose of it. It was a two-dimensional turntable that was tilted at an angle from the horizontal and which rotated very slowly. It was packed with particles so that stress chains could be seen at all times, and not only when particles moved against each other. Because the turntable was packed to such a high degree, the particles never moved against each other as the table rotated. The film crew then decided that they wanted to interview Dr. Behringer in front of this experiment, and I got to listen to the interview as they asked him questions about the research done in the lab and how I was able to assist in the research.

It had taken a while to set up the equipment for Dr. Behringer's interview, so by the time the interview was finished, it was already 3:00. The film crew then wanted to film me performing my 3-D funnel experiment, and then after that, they wanted to interview me about my experiences at the lab this year. It was going to take them some time to set up the equipment in the next room where the 3-D funnel experiment was located, so during that time, I worked on what Dan had planned for me to work on today. There were some PostScript images of piles and experiments that took up way too much memory, and my task was to decrease the amount of space these images took up by decreasing their resolution. I had to figure out how to do this using the available image editing programs on one of the computers in the lab. My second task was to make graphs from data taken from an experiment done on the 2-D turntable last week, but I never got to this task because the film crew was ready to film me doing the 3-D funnel experiment.

I basically had to look like I was carrying out a trial, since the 3-D funnel I had been using had already been disconnected from the capacitance sensor and had been replaced by a smaller, modified 3-D funnel. After this, the film crew asked me questions about what I did for my research, what Mentorship is, why I would recommend this lab to students in Mentorship, what I have learned from my experiences this year, and what I think other Mentorship students enjoyed their experiences this year. I was also asked about the different Mentorship sites of other students, and I listed some of the more interesting places where I knew other students worked at.

I didn't have time to finish decreasing the storage size of all the PostScript images since the van driver came to find me, and I had to leave. It wasn't even 5:00 yet, which is the time I normally leave. Very quickly, I presented the answers to the two questions that Dan had asked during my last visit, and then I left.

### **April 29, 1999**

Today was the last day of Mentorship. Dan helped me to prepare for my presentation for Research Symposium that would take place tomorrow. I got my transparencies made today; I couldn't get them made any earlier because the most recent data that was needed to generate the graphs I would be using had just finished being analyzed after my last visit. For about an hour we discussed the details of what I had

been learning this year, and I practiced what I was going to present tomorrow. Dan said he would be unable to attend my presentation, but Dr. Behringer said he was able and that he wanted to come.

I had written a thank-you note to Dr. Behringer for allowing me to work in his lab, and Dan had asked me earlier this year if I would write him a recommendation to go into his teaching portfolio, so I gave it to him today. This visit didn't feel too "final," since Dr. Behringer and Dan knew that I would be coming to Duke next year, and since I would be majoring in physics, we knew that our paths will cross many more times in the future.