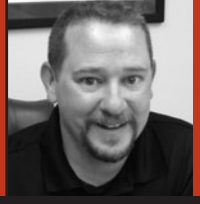

By Jay Jones, PLS

Jay Jones is a partner in the firm of Aubertine and Currier in Watertown, NY where he specializes in construction surveying and machine control consulting. He holds a BS degree in land surveying from Michigan Technological University and an MS degree from Purdue University with an emphasis in geodesy.

Lessons Learned

A subcontractor places concrete with a Somero S-240 laser screed controlled by a robotic total station.

I am continually asked about the opportunities for land surveyors in the machine control market and I have written a couple past articles about these opportunities. But I am more curious about what the next trend is for machine control. What else is over the horizon that we haven't seen yet? What can land surveyors do to help fill the void that machine control has left in our revenues?

Being involved in the machine control market, I continual see new opportunities that arise as the technology takes hold. I am currently working on a project that has a 27,000 square foot building surrounded by 11 acres of concrete parking area. The contractor doing the site work is using machine control to grade the subbase for the concrete parking area. For this project, I created a surface model for the site contractor to use with his equipment. However, as the project progressed, I started talking with the concrete subcontractor about how he was going to screed the concrete parking area. I have worked with many contractors that place the forms on the subbase and then screed the concrete with a power screed.

For this project, the concrete subcontractor is going to place the concrete and screed it with a laser screed which eliminates many of the forms. The laser screed is set up to run off a laser level and it will follow the slope of the laser and screed the concrete to an almost perfect slope. The interesting thing about this project is that the concrete on this project is not just a parking area sloped in one or two directions–it has catch basins in the middle with slopes that vary in multiple directions, making it look more like a wash board than a parking area. This type of parking area is not the ideal situation for using a laser level and a laser screed.

Left: The use of a machine controlled laser screed makes the placement of concrete quicker and more accurate.

Below: Machine control technology makes possible wider than normal concrete pours, eliminating intermediate forms but still meeting the drainage requirements.

However, with today's machine control technology, you can add a system to the laser screed that is controlled by a total station and it will use the total station information to determine the screed's location and grade and slope sensors to measure the slope of the screed board. The interesting part of this situation is that this system works with point information (northing, easting and elevation) instead of a surface model. In this case, the subcontractor needed the point information on the surface, so I created the necessary points on a 15-foot grid along all the concrete joints and was able to gain extra revenue for the project.

A Problem Arises

This past month I ran into a situation that I had never seen before, but with more and more people adapting to machine control technology, it is certainly a situation that anyone could encounter. As the owner of a design firm, I highly encourage my partners and employees to share lessons learned so that we don't make the same mistakes more than once. I wholeheartedly believe in the adage that it is OK to make mistakes, as long as you learn from them.

I was working on another project near this one and I decided to check in and make sure everything was going OK. I had talked the project superintendent the day before and they were having some issues with the GPS dozer with laser augmentation. They figured out that they were missing a part for the system and they were going to have it delivered to the project site the following day. I figured it may be a good idea just to stop in and make sure everything was working fine before I headed back to the office.

When I got to the site, the superintendent and the dozer operator where trying to load the correct surface file into the dozer. Just a bit of background information: we built two surfaces for this project. The first was the Storm Water Pollution and Prevention Plan (SWPPP) surface which included some drainage swales and storm ponds. These will eventually get filled in and graded, but they are needed during construction to make sure no storm water leaves the site during construction. The second surface was the entire finish grade surface for the entire project.

This particular dozer had been onsite before, but it was the previous year when the contractor was doing the SWPPP site work to begin the project. Therefore,

Machine control helps the concrete subcontractor to reduce the amount of excess quantities.

the dozer did not have the finish grade surface for the entire project loaded into the on-board computer (control box). I uploaded the entire surface finish grade model so the contractor could begin fine grading the site.

Soon the GPS dozer and laser augmentation system was up and working and the contractor was trying to bench the system for fine grading the sub-base material under the concrete. I talked to the superintendent and the dozer operator and they were having some issues getting the dozer to bench correctly on one of the bench marks we had set. The system was basically giving them an error that indicated the system was too far out of tolerance. I got up in the dozer and started looking at the settings on the machine. The first thing I noticed was that they had put in a 12-foot vertical offset. I asked why they did that and they told me the system was about 12 feet off and they were just trying to bench the system to the correct elevation.

This raised a number of red flags for me. I can understand the GPS system and hard bench marks showing a difference of up to a tenth of a foot due to GPS variances, but 12 feet? There was obviously another issue besides correctly benching the dozer. I reset the vertical offset in the dozer to zero and went to work trying to diagnose the problem.

When looking at the display in the dozer, it appeared that the dozer and parking area were in the correct location on the site. I reloaded the calibration file to make sure it was working correctly. When I checked all the diagnostic tools, it showed all the components were connected and working properly, the GPS receivers were fixed and the dozer was showing a strong radio signal. Everything appeared to be working correctly, but the dozer showed a 12-foot cut where we should have been at subgrade.

"I can understand the GPS system and hard bench marks showing a difference of up to a tenth of a foot due to GPS variances, but 12 feet?"

I set up the rover next to the corner of the dozer blade and verified that the dozer and the rover were both showing the same northing and easting coordinate. They both checked well. There was still something that was causing a problem.

My next check was to look at the machine dimensions measurements for the blade and the receiver masts. These are the dimensions that are input into the dozer for use in calculating the true position of the cutting edge of the blade in comparison to the location of the GPS receivers. It only made sense that the dimensions were entered incorrectly if everything else checked out. I accessed the machine settings and checked the dimensions. It showed the blade to be about 3 feet high and the antennas to be about 8 above the bolts on the cutting edge. These appeared to be correct. They definitely were not 12 feet off like the dozer was showing.

At this point I asked the dozer operator to bring over another GPS dozer they had on site that was working correctly. I thought there may have been an issue with the data card or a corrupt calibration file on the card. I took the card out of the other GPS dozer and put it in the problematic dozer and the same issue appeared. I then took the data card from the problematic dozer and put it in the other dozer and it worked perfectly. Since the data card worked fine in the second dozer, I know the data was correct and there were no corrupt files.

At this point I was at a loss as to what the problem could be. I had fixed receivers, strong radio signal, correct data and calibration files and a correct machine dimension configuration file. I figured I better get on the phone and start asking for help. I called Milton CAT where the machine was purchased and started talking with various technicians. They said the dozer was at their facility earlier in the month and they had the GPS dozer and the laser augmentation system working perfectly. I also called Keystone Precision Instruments who installed the GPS and the laser augmentation on the dozer and talked with some of their technicians to see if they had any ideas as to what the problem could be.

We all kept coming to the same conclusion. It has to be something with the machine dimension configuration file. We were all under the assumption that somehow, the machine setup file

had become corrupt. Fortunately for us, Milton CAT and Keystone Precision Instruments keep backup copies of the machine control dimensions when they set up a new system. Since the dozer had been at the Milton CAT facility the previous month and completely checked over by a Milton CAT technician and a Keystone technician, they had a copy of the setup file for the dozer. They emailed us the file and I reloaded it on the dozer only to find that the configuration file was not the issue.

At this point, I was completely baffled as to what was causing the issue. Everything looked fine. The system should have been working, but it wasn't. Since we were at the end of the working day, the contractor decided to have Milton CAT and Keystone come up the next day and take a look at the dozer and figure out the issue. By this time I had talked to various technicians at Milton CAT and Keystone and they were all aware of the situation and trying to come up with possible solutions.

Since my schedule was full the next day, I was not able to be onsite when the technicians from Milton CAT and Keystone arrived. They ended up solving the problem very quickly–the radio for the dozer was on the wrong channel! At first this confused me because I had looked at the radio signal and we had a strong radio signal. What I had neglected to figure out was the fact that the *dozer* was on the wrong channel and just a little more than a half mile away was another contractor that was using machine control. We were picking up the second contractor's base station. Apparently that site was on the same horizontal datum, which gave us correct northing and easting location, but it was on a different or assumed vertical datum, which explained the 12-foot of cut we were showing on our subgrade.

In this case, the contractor had his dozer at Milton CAT having the laser system installed and when they check the system at their facility they test it on channel 1. The dozer then was sent to a project that used the laser, but they didn't use GPS, so the GPS system was not used again until it was on this project. If the second contractor not been on channel 1, the dozer would not have gotten radio signal and I would have known to check the channel, but since it was receiving a radio signal, I made the assumption it was the correct channel. I will not ever do that again.

I am very happy that the adjoining site was using a different datum. If they had been using the same datum or something very close, we could have had disastrous results. If there had only been a few tenth's differences, I may not have noticed the issue and they could have graded the entire subgrade using the wrong base station.

My lesson learned from this experience is that you need to verify all the components of the system before you start working. Just because you have radio signal doesn't mean you have the correct one. My biggest concern is that now with more and more contractors using the technology, the greater the chances for overlap in your radio signal. It is only a matter of time before this happens to someone else, so hopefully someone can learn from my mistake. From now on, I am going to make sure I check the radio channel when I start, regardless of whether I have a signal or not.