

# Project Profile

**Rodney Garrett**

## PennDOT About to Embrace GPS Technology

**P**ennDOT (the Pennsylvania Department of Transportation) is in the middle of preparing specifications for using global positioning system (GPS) technology that includes automated precision grading with bulldozers and motor graders. One of the PennDOT team members responsible for bringing the specifications to fruition is Chief of Surveys Thaddeus R. Mikolajczyk Jr., P.L.S. Mikolajczyk has been working closely with PennDOT Project Manager Brian Steffy, R.E., who is in charge of the DuBois-Jefferson County Regional Airport Access Road, a construction project where the use of GPS technology is under scrutiny by PennDOT.

When this access road project is completed, it will link the airport to I-80, 4 miles to the south.

I-80 is the main northern tier interstate highway running from New Jersey to California. Since I-80 is an important freight-transport route, the new access road will not only enable many of the yearly 47,000 air passengers to have easier access to the airport but should attract businesses and light industry to establish warehouses and light manufacturing facilities here. Hoping to entice businesses here, there is an

industrial park next to the airport that is now under construction and is des-



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ignated a Keystone Opportunity Zone, which carries tax-free privileges for the businesses. The park also is a Foreign Trade Zone 254 enabling businesses to delay paying import taxes until the product is sold.

From both PennDOT's and the project contractor's perspective, there is yet more significance to this road project than its link between the airport, the industrial park, and I-80. This is a

major PennDOT construction project where some of the latest GPS technologies for grading are being evaluated and documented. The results will assist PennDOT engineers and construction project managers with drawing up final specifications on using GPS technology on future construction projects requiring precision grading.

Francis J. Palo Inc. of Clarion, PA, is the project contractor and has been instrumental in pioneering the use of GPS technology in the state. Palo recently made a substantial financial investment to purchase GPS equipment that was fitted on two of the company's bulldozers and two motor graders. Palo also has been influential with PennDOT by introducing some of the latest GPS technology to the department for its consideration when writing the new specifications.

Michael Palo, CEO of Palo Inc., and the president of the Constructors Association of Western Pennsylvania, has been

a strong advocate for new technology. He says, "You must be willing to take some risks if you are to move your company forward, and I find this new GPS technology is good not only for the contractor but good for Pennsylvania."

The technology Palo is talking about is known as stakeless grading. This stakeless approach includes both rough grading and precision grading on all phases of road construction. Not

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only did PennDOT approve the use of this technology for the airport access road project, but its project manager, Brian K. Steffy, P.E., has embraced it by working very closely with the contractor in all phases of the project.

The stakeless grading method used on this project is benefiting both parties. Palo's winning bid for the project is \$16.7 million. The contractor started the project in October 2005. According to Palo's Project Manager, Sam Denison, the project should be completed weeks earlier than the designated July 2007 completion date. Denison attributes the shorter completion date, in part, to the faster grading operation made possible by the GPS technology.

The new two-lane road will be 5.2 miles long; its alignment is like that of a French curve where there is a multitude of irregular curves making up an overall arc form. This alignment was deemed the most economical and practical design for constructing the road. Much of the terrain in and around the alignment consists of rolling hills and low mountains, and despite building the road on this curved alignment to avoid the hills, there are still multiple high and low areas to deal with for reaching the wanted grades.

One million cubic yards of ground are being excavated, including overburden and intact rock (approximately 200,000 cubic yards) that is drilled and blasted to fragment sizes 36-inch minus. Cuts along the alignment are to 60 feet deep and fills go to 60 feet high. About 700,000 cubic yards of the excavated materials are used for the fills. The extra 300,000 cubic yards of material are exported from the project site. Slopes left on either side of the cuts and made by the fills are graded 2:1 by the two bulldozers fitted with global positioning systems.

## Topcon at the Top

At the top of the list for this trial are various Topcon global positioning systems, which, according to Denison, have no rivals in its technology. "We carefully evaluated another GPS and even had it demonstrated on this project, but it did not measure up to the performance we have been experiencing with the Topcon 3D-MC system. As far as we [Palo] can see, the Topcon technology is precise and the most reliable to operate," says Denison.

Here is a rundown of the different Topcon GPS components Palo is using to perform all rough and fine grading at this project. First, there is

a HiPer+ wireless, integrated GPS receiver system, which is stationed on a pole at the airport. Since the project is located in the middle of mountains, Palo bought two Topcon Radio Repeaters in case they were needed to overcome signal interferences; however, it was later found the repeaters are not necessary for this project. Denison hypothesizes since the road is being constructed in an arc (rather than a straight line) and the HiPer+ unit at the airport is relatively close to all points along the alignment, the radio repeaters were not needed. Actually, the farthest distance from the road to the HiPer+ is less than 4 miles. Depending on the terrain and canopy conditions, the HiPer+ has exceptional transmitting capabilities as was demonstrated on a recent Pennsylvania Turnpike construction project where it emitted a strong signal that was received 13 miles away.

If there is a heart to the Topcon GPS, it is the HiPer+. It is the first system with a wireless, integrated GPS+ receiver and radio. The unit is compact and lightweight for easy handling and simple to install at a fixed station. Important is its dual-constellation satellite tracking. The dual-constellation (GPS plus Glonass) tracking will provide

## The Rest of the Story

Keith Klingensmith, P.E., technical representative for Topcon's local master distributor, Productivity Products & Services Inc. (PPS) of Saxonburg, PA, was very instrumental from the onset in not only assisting the contractor on what Topcon equipment to select but also training the company's personnel in how to use the equipment.

Klingensmith unwittingly gives a good testimony about the value he sees in Topcon GPS by an important action he took. Upon learning the details about the system, he became so impressed with this futuristic technology made available for today's projects that he made a career change.

Klingensmith was a construction project engineer with PennDOT, in District 12, for 15 years and happy with his professional status at the department. About two and a half years ago he accepted an invitation to witness a Topcon GPS demonstration. A contractor who was building a box culvert on one of Klingensmith's projects was interested in learning about the system and invited Klingensmith to accompany him to the demonstration.

The demonstration was made by PPS. "They demoed the Topcon rover pole and I was so impressed with its capabilities that I had an in-depth talk after the demonstration with the president of the company, David Reitmeyer. After our conversation, he suggested I should consider joining the company as a technical rep. I went home and talked it over with my wife; two weeks later I joined the company. Many people were surprised that I would leave the good position I had with PennDOT, but I am so convinced this Topcon technology is leading the way to changing the way grading will be done in the near future that I decided I wanted to be part of it all," says Klingensmith.

40% more satellite coverage than the more conventional GPS-only tracking systems. This superior tracking, in turn, greatly improves uptime even when in challenging environments where the GPS-only systems go down.

Notable also is the center-mounted RTK UHF antenna for boosting its RTK performance and distance without compromising the strength of its GPS signals. Additionally, the integrated 40-channel dual-frequency receiver features the integrated Bluetooth technology; it also features Co-Op Tracking technology for exceptional under-canopy performance.

There are two different type control systems mounted on the bulldozers and motor graders. The Caterpillar D8T bulldozer has the 3Di-GPS+ Indicate Control System. This system carries with it a modest price tag and is suitable for rough grade applications especially where substantial in situ ground is to be excavated making shallow to deep cuts. Likewise, this system lends itself well for bulk filling and backfilling activities. This GPS does not have automated control, so the operator is completely in charge of operating the bulldozer just as he is when operating the machine without the GPS indicate control. However, guesswork associated with traditional grading and backfilling and the constant need of a grade foreman are eliminated, thus reducing grading time while achieving superior grading results.

Mounted on the Caterpillar models D5N bulldozer and 120H motor grader and a John Deere model 770 motor grader are Topcon 3D-GPS+ automated control systems. The D5N bulldozer also is used for rough grading, but its grading procedure is automatically controlled, and with the base station in place the grading tolerances are within 0.1 foot or less. Precise location points are achieved by triangulation. This system tracks all available satellite

signals, thus ensuring greater solution quality and integrity.

With dual-constellation tracking capabilities, the optional Co-Op Tracking System integrated with the 3D-GPS+ Control System, satellite tracking integrity is maintained (locked) when the bulldozer or motor grader is grading near or under canopies such as trees. To illustrate, if 30% or more of the sky is blocked from the receiving system by a canopy (trees etc.), the value of tracking is locked (if all satellite signals are temporarily blocked), thus ensuring uninterrupted grading activities.

Added to the 3D-GPS+ systems installed on the two motor graders is the optional Millimeter GPS for an even more precise grading control system. It enables the motor graders to automatically perform fine grading (measurable in millimeters) not readily reachable by using traditional staking or standard GPS methods. Only one PZL-1 transmitter with its Lazer Zone technology is required for operating multiples of the PZS-MC-equipped machines and the PZS-1 Positioning Zone Sensors that are mounted on GPS range poles.

Palo is using two PZL-1 transmitters on this project that are placed about 500 feet apart because of the height variations and grades found along the road alignment. Stakes are also placed at these 500-foot intervals so PennDOT can verify the preciseness of the Millimeter GPS using traditional survey methods. On PennDOT projects, stakes are specified to be installed at 25- to 50-foot intervals along the complete length of a road alignment. This project called for 25-foot intervals for subgrade and 50-foot intervals for the cuts and fills. Essentially, 10 to 20 stakes were avoided per 500 feet, as was all the survey work that goes with it.

Dennison says he is erring on the conservative side by making 500-foot intervals; there are sections along the

alignment where the two PZL-1 transmitters could be spaced up to 900 feet apart yet get outstanding precision grading results.

Palo constantly verifies all grading activities by monitoring the grades at random points with Topcon Pocket-3D FC-100 field controllers running its Pocket 3D software in concert with PZS-1 mounted on the range poles. Troy Wolfgang, survey technician, is in charge of this activity and Dale Zimmerman supervises it. Palo has four FC-100 units (includes field controller software).

### **GPS Benefits**

There are significant benefits to be reaped from using a GPS or its use on PennDOT road projects would be a no-go. Mikolajczyk explains, "We do not specify what brand GPS equipment a contractor uses as long as he gets the grading results we specify. The equipment either performs or it doesn't."

Here is a short list of benefits that PennDOT associates with using GPS technology, according to Mikolajczyk. These benefits are significant enough for PennDOT to justify making an addendum covering GPS technology use, which will be inserted into the PennDOT Publication 408; Section 210 Specifications.

- A superior highway ride quality is probable.
- Faster completion dates for the road projects can be expected.
- As more contractors use this cost-effective technology, bid pricing will be lowered.

Steffy projects there will be additional benefits realized once the practice of this technology comes into fruition on various PennDOT projects.

There are benefits to be enjoyed also by the contractor. Dennison has his own short list of benefits that he says can be realized by the contractor using the Topcon GPS technology.

- At this project, direct labor costs

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for doing the grading and grading monitoring work are reduced by more than 60%. This is because the grading crews are reduced in numbers of participants per crew; this holds true for rough and fine grading activities, albeit the number of members per rough-grade and fine-grade crews differ respectively.

- Grading production has doubled. Simply, the dozers and graders are that much more productive.
- The improved bottom line on the profit and loss sheet is where the above listed benefits lead.

Is there a downside to practicing this technology? None that is noteworthy. Dennison says, “We [Palo] were willing to take the steps necessary to enter into this new technology, and we did it knowing there would be a learning curve for the operators as well as the supervisors. We took on a small road intersection construction project prior to this project to become familiar with using the Topcon GPS. That small project was sufficient for completing on-the-job training so when we started this project we knew what to expect.”



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Author **Rodney Garrett** specializes in construction subjects.