By Shawn Billings, LS

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Leica System 1200 *(Part 1 of 2)*

Tim "The Tool Man" Taylor once said, "You've got a jet engine and you've got a riding lawn mower. It was only a matter of time until someone put those two together."

Jet-powered riding lawn mowers notwithstanding, many of the new technological developments going on around us are built on nothing more than intelligently merging two or more useful devices into one. These developments are particularly noteworthy to the contemporary practicing surveyor.

From conversations I've had with surveyors around the country, there seems to be a steady migration toward solo or near solo operations. This has been made possible largely because of advances in reflectorless and robotic total stations and real time kinematic GPS instruments. These same surveyors constantly lament the bulk of gear that is now being carried by only one or two people. Merging multiple devices into one begins to border on the miraculous when it is just you toting gear to a job, through brush and over rough terrain, a half mile from the survey chariot.

None of these solo-enabling technologies are effective in all situations. Each has its own merits and detractions. Placing robotics and GPS together in a single integrated package seems rather daunting, both for the manufacturer willing to attempt it and the user willing to buy it. But that is exactly what Leica Geosystems has done in creating the System 1200.

TPS1200+ shown with RH1200 RadioHandle

The Concept

The System 1200 is an arrangement of three hardware components: the TPS 1200+ (Total station Positioning System),

Leica ATX1230 SmartAntenna, 360° prism and RX1250 data collector combine to make the SmartPole.

The TPS1200+ can be operated using onboard software that is identical to the software found on the RX1250.

the RX1250 (data collector and controller), and the ATX1230 SmartAntenna (GPS RTK rover) which are all held together, powered and tethered by various accessories.

Within the RX1250 is the SmartWorx software which operates both the total station and GPS. For the office, Leica Geo Office (LGO) is used to perform a variety of tasks such as post processing, adjusting, editing, viewing, printing, exporting, transforming and COGO, just to name a few.

With respect to measurements, whether by GPS or total station, surveyors are ultimately interested in only two things: the coordinates of measured features and the accuracy of those coordinates.

Because of this *results oriented* point of view, it is easy to forget that even though the points measured by GPS and by total station can work in wonderful harmony with each other, the calculations and methodology to determine those positions are remarkably unalike. This adds a great deal of complexity for the software to sort out, but it also adds an incredible amount of redundancy in measurement determination.

Consider that if you measure two points with a total station and determine the distance between them to be 99.99 feet, and then you use GPS to measure the same two points and determine the distance between them to be 100.01 feet, you can enjoy a great deal of confidence that those two points are 100 feet apart. For the trimmed down survey crew, however, getting those two shots would mean setting up the instrument and shooting the two points conventionally and then setting up the RTK and shooting them again, costing not only setup time, but also travel time from setup, to point to point, twice.

I didn't realize how much flexibility existed in the System 1200 until I began poring over the documentation. Originally, the configuration was limited to placing the SmartAntenna on the TPS and only positioning the instrument station by GPS. With the current system, the user can place the SmartAntenna on the instrument (as the SmartStation), on the pole above the prism (as the SmartPole) or even use it on a pole by itself and break into two one-man crews–one with the robot and one with the RTK. Furthermore, Leica makes the system available with numerous options. As the customer, you can pick the model that fits you best.

The TPS is available as a standard total station measuring angles and distances all the way up to reflectorless, long range reflectorless, automatic target recognition (robotics), Power Search, and more including all points in between.

Interestingly, the documentation also indicates that a base model TC-1200+ (a standard total station that measures angles and distances) can be equipped with the SmartAntenna. You may recall David Ingram's article, "The Totalizer" [Nov 2007] in which he describes the design and manufacture of a handle for his total station built to accommodate a GPS receiver. The idea is not without merit.

Consider that the average setup, even for a few shots, is in the range of fifteen minutes and typically much longer. Also keep in mind that the NGS OPUS-RS utility is available, which can determine positions over much of the U.S. using submitted dual frequency GPS data files as short as ten minutes in length, and you can see that even those not looking for all the bells and whistles could

J.D. Billings, father and partner of the author, operating the SmartPole.

benefit from the System 1200, which adds data transfer and much more to Ingram's Totalizer.

So, let's look at the components individually and then discuss how they work in concert together, beginning with the TPS1200.

The TPS1200+

Having used robotics for about a year now, and from conversations with seasoned robotics veterans with vastly more experience, there are certain drawbacks to robotics that have been painfully endured since their inception. Perhaps topping the list is the sheer weight of robotic instruments. The servos typically add a tremendous weight over the manual models.

Leica has addressed this issue, and the weight of the TPS is incredibly light. In its compact hard-shell carry case, it is comparable in weight to our very light weight manual instrument. At first look, I could not believe that it could possibly be a servo driven robotic instrument.

Another issue at the top of the drawback list is the typically poor power performance of robots. Those servos require juice and tend to drink it up gluttonously, requiring multiple internal batteries or more bulk and weight in the form of an external battery and cabling.

The GEB221 battery powers the TPS and lasts easily for an entire day on a single charge, making it an instant hit here. Changing the battery is easily done with a quick quarter turn of a knob located on the instrument standard, which releases the battery and its cover from its recess. Remove the battery from the cover, replace with a charged battery and return it to the standard with another quick quarter turn.

For survey gear, Leica presently makes two batteries: the GEB221 and the GEB211. All of their current offerings operate on one or both of these batteries, the 221 being a 4Ah battery and the 211 being a 1.9Ah battery. In a pinch the TPS can run on the smaller 211, even though it is designed to run on the 221. The batteries have the same cross sectional area, with the 221 being roughly twice as tall.

With the batteries designed in this way, charging is a lot less confusing at the end of the day. A single charging tray, the Pro Charger, accommodates four batteries at one time. It only charges two at a time, but as one battery is completely charged, the charger switches to charge the next one, until all of the batteries are charged.

The Power Search feature is incredibly fast at reacquiring the prism.

In the field, a single spare battery covers the SmartAntenna, the radios, the controller or the total station.

As for cables, I was issued only one cable with the entire system, and that was for the GPS base station. Robotic operation was completely cable free. The RH1200 (Radio Handle) snaps into the top of the TPS1200 and works excellently. Powered by the total station, I had no extra batteries to keep up with, and since it snaps onto the top of the instrument where waiting electrical contacts are perched, I had no cables to fiddle with either. This allowed for a very quick instrument setup.

In the standard located opposite the battery housing is a concealed compartment for a Compact Flash port accessed by the same quarter turn knob used for the battery compartment. Retrieving data stored on the instrument is as simple as removing the card and placing it in a card reader on your PC.

The TPS 1200+ can be operated using onboard software that is identical to the software found on the RX1250. The full color touch screen display has an identical appearance to the RX1250 and optionally can be configured with two displays. It features a similar keypad to the RX1250 less the Qwerty keypad, and the designated caps lock and space keys.

The horizontal and vertical motion knobs are located on the right and left standards (in Face One) respectively. The motion is an endless drive, and the instrument only responds to the knobs when powered on.

The TPS 1200+ has a 6 arc minute spirit level and no vial level for precise leveling. Fine leveling is performed using the internal compensators via a leveling display on the screen. It is equipped with a standard laser plummet although it can easily be placed on an optical tribrach for those who prefer to force center their traverse.

Tracking performance was excellent and I was impressed that I could walk at a normal gait within twenty feet of the instrument without losing lock. The instrument kept right up with me. I had no issues of it tracking anything other than the prism and when I did lose lock by going behind an obstruction, I used the Power Search feature.

To be honest, before I used the TPS I was inclined to think the Power Search was a gimmick, and a pricey one at that. The Power Search feature doesn't come cheaply. But it was incredibly fast at reacquiring the prism. Basically it sends out a very wide (±36°) fan beam as the instrument turns at full speed to the right. Once it receives a return signal, it stops and performs a vertical search. The search locks the instrument onto the reflective signal found by Power Search and interrogates the signal to determine if the signal is coming from something in the shape of a prism. If the return signal doesn't pass the test, the TPS ignores the offending object and continues the Power Search.

Typically the Power Search will only lock onto the prism, or at least it did for me. From a loss of lock to being ready to work again required well under five seconds when tested. Even in a full parking lot with plenty of reflective tail lights, headlights, windshields, chrome, etc., it turned right to the prism without any distraction.

Robotic Trivia

Next time you play "Trivial Pursuit" or "Are You Smarter than a Fifth Grader?" you'll be glad you read this section.

Robotic total stations use a form of digital camera to track the prism, watching for a return from the infrared signal emitted from the instrument and reflected by the prism. Most use a CCD (charge coupled device), Leica opted for a CMOS (complementary metal-oxide-semiconductor) based sensor which offers a more compact sensor, and as claimed by Leica, a clearer, higher resolution image of the prism that adds the ability to discriminate the prism from noise more effectively.

Interestingly, Leica makes use of the image for more than pointing the instrument to the prism. If in Tracking mode, the instrument will turn to within 130 arc seconds of the prism and then use the image from the CMOS camera to calculate the remaining angular distance to the target. According to Leica this can be done with a typical accuracy of around two to three arc seconds. If the instrument is set to Standard, the instrument will turn to within 16 arc seconds, with a typical accuracy of one arc second.

My contact person with Leica Geosystems, Shannon Hixon, Product Marketing Manager, explained that this was implemented to reduce wear on the robotic servos and improve battery life as the instrument isn't constantly making minute adjustments to the prism.

With reflectorless technology, many of today's instruments employ two EDM emitters–one for reflector measurements and one for reflectorless measurements. Leica has employed one single emitter, sending its beam through a wheel that can be set to one of three positions. In the first position, the wheel turns to place an internal prism in the path of the emitted beam for a calibration check on the instrument. In the second position, the beam is passed through a lens that diffuses the beam for prism observations. In the final position, the beam is allowed to pass through a hole with no alterations made for reflectorless measurements. Leica also uses a blended time of flight (TOF) and phase measurement technique instead of one or the other to determine reflector and reflectorless distances.

My impression from the TPS1200+ was very positive. I came away really appreciating the lengths Leica has gone to in making robotic surveying easier, more compact and more efficient while not sacrificing on accuracy and features. In the next issue, I'll review the GPS and data collector side of the System 1200 as well as the office software.