

TRIMBLE® INTEGRATED SURVEYING™ TECHNIQUES

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ABSTRACT

Trimble's Integrated Surveying™ solution was introduced in 1998 with a field controller and software that provided a common file and user interface to GPS and conventional survey instruments. Since then Trimble products have continued to develop Integrated Surveying by providing connections to multiple survey devices, seamless data transfer and the ability to combine data in a single project to create homogenous data sets. This paper describes how Trimble products support Integrated Surveying for real-life survey applications. It also discusses techniques that combine, transfer and process data from GPS and conventional instruments. The techniques are applied to real-world survey applications to provide customers with an understanding of how Integrated Surveying can increase survey productivity

INTRODUCTION

Trimble first introduced Integrated Surveying techniques with the GeodatWin controller in 1998. The GeodatWin was the first controller that provided connection and control of both conventional survey instruments and GPS receivers. Data from each device was also stored and managed in the same job file, allowing positions to be measured with either GPS or conventional instruments.

In 1999, Trimble furthered Integrated Surveying with the TSCI™ handheld controller running Trimble Survey Controller™ 7.75 software. The rugged TSCI provided connection to Trimble GPS receivers and many third-party conventional total stations.

Since then, Trimble has continued developing Integrated Surveying solutions that allow users to easily connect to and control survey instruments without having to exchange field devices or use

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different field software applications. Integrated Surveying offers many benefits, including:

- Surveyors can efficiently establish site control via postprocessing, RTK and conventional survey instruments with a single controller and field software. Surveyors only have to learn one field software application, making them more productive more quickly. In addition, the survey data can be combined and adjusted in a single file to efficiently establish homogenous control.
- GPS techniques can extend a total station survey without the need for extensive traversing, which saves time on the job site.
- Surveyors have more flexibility when performing topographic surveys in that the most appropriate survey tool depending on the environmental conditions of the site. For example, the surveyor can take GPS measurements in large open areas and total station measurements in vegetated areas or areas with overhead obstructions.
- Surveyors have more flexibility when performing stakeout, particularly on large construction sites, where obstructions can often interrupt the use of GPS or total station techniques. Since the technologies are complimentary, a surveyor can use the most appropriate tool to complete a survey using the same data collector and job file. This saves time and minimizes user errors.

INTEGRATED SURVEYING EXAMPLES

The core of Integrated Surveying comprises the controller, field software, and office software. The following examples use the Trimble® CU controller running Trimble Survey Controller; postprocessing and data adjustment is performed in the Trimble Geomatics Office™ software. However, any Trimble controller, or field or office software could substitute.

EXAMPLE 1: INTEGRATED CONTROL USING A TOTAL STATION AND POSTPROCESSED GPS

To establish control quickly and easily, use a Trimble S6 Total Station to establish a local control network and then a Trimble R7/5700 or Trimble R8/5800 to connect the local control network to geodetic control:

1. Set up the backsight prism and attach the Trimble GPS receiver/antenna on top. See Fig. 1.



Figure 1: Integrated Backsight Measurement using Trimble S6 Total Station and Trimble R8

2. Wirelessly connect the Trimble CU to the GPS receiver and start a postprocessed survey. With a Trimble 5700 / R7, just select the data logging button to start logging data.
3. Set-up the Trimble S6 on the instrument point and perform the station setup, using the Trimble CU. Measure rounds to the backsight point and foresight point(s) or measure topographic points.
4. End the conventional survey and postprocessed survey.
5. Repeat the procedure as the conventional traverse extends.
6. In the office, download all data into Trimble Geomatics Office. Postprocess the data with coordinated base station data. Perform a combined network adjustment using the established base station control.

The local control is now established and referenced to the geodetic system. Coordinates can be exported back to the field software for continued survey use.

The simple use of postprocessed GPS during a total station survey allows control to be efficiently established. The combination of the survey tasks allows the survey to be completed more quickly, and provides additional data quality through independent verification of GPS and conventional measurements. Control can be established faster, more reliably and with only one controller.

EXAMPLE 2: TRIMBLE IS® ROVER

The ultimate Integrated Surveying setup is the Trimble IS® Rover, which fully integrates a Trimble S6 Total Station and Trimble R8 GPS system. See Fig. 2.



Figure 2: Trimble S6 Total Station with Trimble IS Rover

The ultimate setup, combining robotic operation with a VRS capable rover, provides full in-field flexibility, greater data collection efficiency, and an increase in productivity for a variety of survey applications. With the Trimble IS rod, surveyors can:

- Use the complimentary technologies where they truly compliment each other: total station in areas with overhead obstructions and GPS in open areas or when line of sight is temporarily

obstructed. When the total station line-of-sight is obstructed, quickly changing to GPS to measure a few points is always going to be much faster than establishing a new instrument point, moving the total station, and then performing a new total station setup. The total station can also be placed in the most suitable location for line-of-sight operation, independent of any overhead obstructions.

- Increase efficiency at establishing control by measuring points with either technology, or both. GPS measurements can be easily transformed to ground control, or coordinates can be established to provide the orientation for total station measurements.
- Improved data integrity by measuring points with both technologies for truly independent verification and confirmation of survey accuracy.
- Operate both technologies independently when required to complete a survey in a timely manner, or to dramatically improve productivity. The survey data can be easily combined in the field or office to create a single, homogenous data set.

To illustrate how some of these benefits can be applied in a real-world application, a case study was performed comparing an integrated rod approach to other survey methods.

TRIMBLE IS ROVER: A CASE STUDY

The following case study compares the Integrated Surveying approach to more traditional survey techniques, and evaluates the time savings achieved.

To complete the task, a surveyor had to:

- Establish local control, i.e., connect to three known coordinates within 3 km of the site and establish three new points on the site.
- perform a topographic survey of the site;
- stake out a building form and utility lines;

One corner of the site is heavily obstructed by overhead vegetation, so the GPS control had to be established outside of this area. This would affect our ability to perform topographic and stakeout activities within this area using GPS alone.

Fig. 3 displays the survey area with the site enclosed in yellow. Existing control marks are also denoted.



Figure 3: Case Study Site

We evaluated the time taken to complete different parts of the job using four different survey methods:

- Total station only
- GPS VRS only
- VRS to establish total station coordinates
- Trimble IS Rover

CONTROL RESULTS:

Table 1 shows the time each survey method took to perform the control survey.

Establishing Control	Time taken
Total station only	1hr 53mins
GPS VRS only	46mins
Using VRS to establish total station coordinates	1hr 10mins
Trimble IS Rover	46mins

Table 1: Time Taken to Establish Control

Based on these results, GPS VRS and the Trimble IS rover were clearly the most efficient techniques. Using a combined total station and VRS occupation was limiting for simply establishing control as it involved additional time to set up the instrument at each point. However, both the control and topographic surveys could be conducted simultaneously, so the time for the topographic survey (shown in Table 2) does not include the setup time for the total station only and combined total station and VRS occupations.

TOPOGRAPHIC SURVEY RESULTS:

Table 2 shows the time each survey method took to perform the topographic survey.

Topographic Survey	Time taken
Total Station only	2hrs 20mins
GPS VRS only	1hr 40mins* ¹
Using VRS to establish total station coordinates	2hrs 20mins*
Trimble IS Rover	1hr 30mins

Table 2: Time Taken for Topographic Survey

The Trimble IS rover was clearly the fastest performer for the topographic survey. Its speed and efficiency were assisted by the ease in which users could switch to total station measurements in the obstructed areas where GPS VRS positioning was not possible. In addition, objects that were obstructed from line of sight to the instrument could be easily positioned by switching from total station to VRS. Flexibility was the key factor in reducing the survey time of the Trimble IS rover.

¹ GPS could not be used to locate all points on site. A total station setup had to be used to measure points that were located in an obstructed area.

STAKEOUT RESULTS:

Table 3 shows that the Trimble IS rover was the fastest method for the stakeout survey by approximately 15 minutes.

Stakeout	Time taken
Total Station only	54mins
GPS VRS only	46mins
Using VRS to establish total station coordinates	54mins
Trimble IS Rover	30mins

Table 3: Time Taken for Stakeout Survey

Most points could be easily positioned with VRS, which provided the biggest time savings. However, VRS could not be used to locate two points in the heavily obstructed area. A total station setup was required to position these two points. This created an additional problem since development of the site with heavy machinery had resulted in the removal of one of the control points. Since this control point was required as the backsight for the station setup in the heavily vegetated area, it was necessary to re-establish the point.

The total station, GPS VRS and VRS for total station coordinates methods all required the control point to be re-established. However, in the case of the Trimble IS Rover, it was more efficient to simply measure three VRS points for use in a resection to establish the orientation of the total station setup. Using the other three survey methods (without the Trimble IS Rover), an additional traverse station had to be established to provide measurements to the obstructed points.

Additional time savings were obtained with the Trimble IS rover when verifying the stakeout points. With the Trimble IS Rover, GPS and total station measurements were observed as each point was positioned. This process produced immediate independent verification of the points being staked. The other three methods required either re-occupying or taping between points to verify that they had been positioned correctly.

RESULTS FOR ALL SURVEY TASKS

Table 4 shows that, overall, the best workflow efficiency was achieved using the Trimble IS Rover.

Total	Time taken
Total station only	5hrs 07mins
GPS VRS only	3hrs 12mins
Using VRS to establish total station coordinates	4hrs 24mins
Trimble IS Rover	2hr 46mins

Table 4: Total Survey Time

While GPS VRS operation is very efficient in areas where satellite visibility is good, being able to easily combine the best of both technologies in an integrated solution reduced the overall time for the job. The surveyor could be more flexible and creative in performing the survey, using the best tool for the task at hand.

CONCLUSION

Trimble's Integrated Surveying techniques provide surveyors with greater flexibility and control over how to perform surveys. Data can be combined either in the field or in the office to provide integrated solutions. The ability to easily combine the data and survey technologies provides an overall increase in survey productivity.

A case study was performed using different survey methods to ascertain the benefits of Integrated Survey techniques. The case study found that the greatest increase in productivity could be gained from using Integrated Surveying techniques that utilised the complimentary aspects of GPS and Conventional surveying. The Trimble IS rover was found to be extremely flexible and efficient in performing a variety of survey tasks.

To learn more about how Trimble Integrated Surveying solutions can help you and your business, please contact your local Trimble authorized distribution partner. Locate a dealer on our website at <http://www.trimble.com/locator/sales.asp>.