Low-Cost GPS Survey System Speeds Survey Work In Developing Countries

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Key words: infrastructure development, global positioning system, ProMark2 survey system, low-cost, easy to learn, eleven languages

SUMMARY

Global Positioning System (GPS) techniques continue to prove themselves in a wide range of survey applications worldwide. There is some user resistance, however, in developing countries, where cost and complexity can sometimes act as barriers to acceptance. Infrastructure work, often done by charitable and non-profit groups, is typically performed under tight budget constraints and with the assistance of local workers with limited technology training and experience. Simpler, less costly systems are needed in these areas. In this paper, we discuss the work of Water Missions International (WMI) and its success in overcoming these barriers in Haiti and Honduras with the use of the ProMark2 Survey System from Thales Navigation. WMI has used the ProMark2 to install custom-designed community systems for water treatment and distribution, wastewater management and storm water control. Similar projects are also underway in Africa and the Middle East.

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1. INTRODUCTION

As a Christian non-profit organization dedicated to helping solve a variety of water problems in developing countries around the world, Water Missions International custom-designs community systems for water treatment and distribution, wastewater management and storm water control. WMI has active current projects in North and South America, Africa and the Middle East.

WMI's experience with these projects has convinced it that non-profit groups like WMI are uniquely able to deliver these critical infrastructures efficiently and with minimum waste and bureaucracy. At the same time, non-profits are often faced with tight funding situations and find themselves looking for ways to do more with less.

Recently, for instance, WMI has begun to use the Thales Navigation PromMark2 survey equipment in site evaluations, establishing boundaries, surveying as-built features, bringing survey control to job sites and for mapping and navigating in potential project areas. The result has been significant time savings, which ultimately means lower overall project costs. In terms of WMI's overall effectiveness as an organization, the technology means solving more water problems within existing funding limits.

2. WATER MISSIONS INTERNATIONAL: BACKGROUND AND HISTORY

Water Missions International had its origins in General Engineering Laboratories, a small environmental consulting firm founded by Molly and George Greene III, the co-author's parents, in Charleston, South Carolina, in 1981. That company grew to become one of the top ten environmental testing laboratories in the United States and one of the largest environmental engineering consulting firms in South Carolina.

In 1998, General Engineering Laboratories responded to the devastation in Honduras caused by Hurricane Mitch by designing, constructing and delivering six portable water treatment units, each capable of producing safe drinking water at the rate of ten gallons per minute. Within three weeks, 16 company volunteers were in remote parts of Honduras setting up the water treatment units. Other projects followed, and in 2001, the Greenes sold General Engineering and used proceeds from the sale to establish Water Missions International. The organization is currently involved in important projects in Ecuador, Haiti, Honduras, Mexico and Uganda, and it recently teamed with FedEx, the Southern Baptist Convention, International Aid and the Department of Defense to provide portable water treatment units to war-torn areas in Iraq.

Like most non-profits, WMI relies on funding from a variety of sources: government grants, churches, foundations and individuals. Suggestions for potential projects come to us from various groups and agencies. The first job is to evaluate the site and the project to determine whether there's a feasible solution to the problems and then put together a plan and a cost estimate.

Each project WMI considers entails a thorough site evaluation. That means visiting the site and gathering all the relevant information about the current water problems and available resources.

3. CONSOLIDATING SITE EVALUATION TRIPS SAVES TIME AND MONEY

Until its recent acquisition of a ProMark2 GPS unit from Thales Navigation, WMI did site evaluations in two phases, with each phase involving a separate trip to the site – typically a difficult and expensive undertaking, given the remoteness of the sites. The first phase is to determine whether the project was viable – that is, whether there is any practical solution, based on available water resources and funding, to the existing problem. If it has determined that the project is viable, the team returns on a second trip to gather more information and survey the site.

Since the acquisition of the ProMark2 WMI has been able to eliminate the need for a second trip by incorporating the survey into the initial visit. The reason, of course, is speed. Unlike older line-of-sight total station survey equipment, a ProMark2 system with its two GPS receivers can be set up quickly and operated by a single person. Among its many advantages for WMI's purposes is its Stop-and-Go survey mode. This feature allows surveyors to collect large numbers of points very quickly. One of the receivers is fixed as a base station while the other, called the rover, is used to collect relevant data points. The data from the base station is then used to correct the error in the GPS data received by the rover. Once the base station is set up, the rover can collect data anywhere within a 20-kilometer radius and achieve centimeter-level accuracy relative to the base station.

4. SURVEY ACCURACY IS CRITICAL IN CALCULATING COST ESTIMATES

Accuracy is critical in the group's site surveys. Distances between points and elevation changes are all part of cost estimate calculations, taking into account piping requirements or the need for pumps or towers to overcome pressure drops, for instance.

ProMark2 is small, lightweight, and is exceptionally affordable for a professional system, offering high-quality results at the lowest cost – about €5,600 for a two-receiver configuration with software. For this price the customer receives everything required to perform centimeter-level surveying except a tripod and range pole (Figure 1). (A low-end optical line-of sight total station system, by contrast, sells for as much as €8,000.) A three-receiver system is only €2,240 more but allows the user to double his work, because a single base can work with two rovers. In addition, the ProMark2 delivers a combination of post-

processed, centimeter-level post processed survey capabilities with stand-alone, real-time, sub-three-meter reconnaissance, navigation and mapping capabilities, all in a single system (Figure 1).

Figure 1: The ProMark 2 system includes two or more ProMark2 GPS receivers, GPS antennas, and all ancillary components required to let the user setup the system and produce quality survey data in a minimum amount of time.

As a solution for survey projects in developing countries, ProMark2 offers another advantage: The receiver interface is multilingual (English, French, German, Dutch, Finnish, Spanish, Italian, Portuguese, Swedish and Russian), making it simpler to teach local personnel the basics of data collection. The post-processing software is also multilingual (English, German, French, Spanish and Russian).

The navigation capability of the ProMark 2 particularly comes in handy in remote regions where one can easily get lost. With the ProMark2, WMI can automatically track its route and mark waypoints for return travel with directions, bearings and even an ETA. Road data bases (maps) are available in great detail for the US and Canada and for Europe using the Magellan MapSend software that comes with the receiver. For other regions of the world MapSend Worldwide, with major roads and intermediate roads, rivers, and other navigational features is available. The user can even load their own maps created in the ESRI .shp format.

WMI gave the ProMark2 its first workout in site evaluations at six locations in Haiti last August (Figure 2).

Figure 2: Collecting the coordinates of a storm drain cover in Haiti.

The ProMark 2's ease of use allowed even those with no formal survey training to operate it with only a little instruction, a big advantage in many developing areas. The team's Piper Cherokee pilot, who flew into Haiti for the project, began using the ProMark2 almost from the start. The sites were all densely populated areas on the outskirts of Port-au-Prince, in many cases consisting of compounds housing churches, schools and community buildings. The sites had various, typically inadequate, potable-water supplies, and in most cases waste water dumped directly into holes in the ground seriously contaminating such drinking water sources as did exist. The projects are all funded by the Rotary Clubs of South Carolina.

The site evaluations produced a number of recommendations, from drilling deep wells to disinfecting and distributing existing supplies from springs and other sources. WMI also proposed solar-powered pumps for some of the sites, a technology requiring a significant initial investment, but one that tends to be sustainable and requires little in the way of maintenance and operating expense. Sustainability is a key requirement at all the sites, since reliable maintenance is difficult to guarantee, and equipment that breaks down often remains unrepaired.

5. POTABLE WATER: 40,000 GALLONS A DAY

WMI also proposed various types of wastewater treatment systems, from septic tanks and drain fields to oxidation ponds. At many of the sites, the team also recommended elevated storage tanks to provide water during the communities' frequent and regular power outages. In all, the six water systems – at Croix-des-Bouquets, Crochu, Fond Parisien, Gorman, Lilavois and Thomazeau – are designed to provide some 40,000 gallons of potable water daily to about 6,000 people.

The site surveys provided by the Thales Navigation ProMark2 units were invaluable. The teams were able in every case to check data by interfacing the ProMark2 with a laptop PC in the field to create a map (Figure 3).

Figure 3: Downloading and processing ProMark 2 data with a laptop computer is easily done in the field. Here the processed coordinates are used to create a map of the job.

The maps, of course, act essentially as blueprints for the overall projects. WMI originally budgeted seven days in the field for the survey work. With GPS technology, they were able to complete it easily in five.

Nearly all of WMI's income is from charitable sources, and the organization feels it has an obligation to donors to efficiently account for all expenses and to economize wherever it can. Tax-exempt status and volunteerism go a long way in that direction. So does the research and

development that seeks out the most cost-effective technologies in the field. But important savings are also in the details: the tools and systems teams use every day. The ProMark2 and the low-cost GPS technology it embodies is one of the most cost-effective technologies we have evaluated to date.

BIOGRAPHICAL NOTES

George Green, who received his BS degree from Clemson University, is a process engineer for Water Missions International in Charleston, South Carolina, a Christian nonprofit relief and development organization focused on providing access to safe water to people in developing countries.

Mr. Greene's responsibilities include engineering design and development, focusing on potable water, wastewater, and storm water, as well as in-country assessment work and project implementation. His experience includes time spent on projects in Afghanistan, Belize, Haiti, Honduras, and Pakistan. He is also responsible for ongoing improvements to the Living Water Treatment System, which is used in emergency relief and development for production of potable water from contaminated water sources.

Tomas Blaha, studied Surveying Engineering (Geomatics) at the University of Prague, Czech Rep., the University of Stuttgart, Stuttgart, Germany and the University of Calgary, Calgary Canada. He graduated Dipl. -Ing. in 1995 from the University of Stuttgart. His thesis was on airborne gravimetry. From 1995-1999 he worked for Sokkia as a Regional Sales Manager in Berlin. From 2000-2002, he was Sokkia Area Sales Manager, Eastern Europe at their European Headquarters, and later became GPS Marketing Manager, Europe. Since 2002, he has been with Thales Navigation in its headquarters in France as Marketing Product Manager (land survey).

Robert W. Snow received his B.A. degree from the University of California, Santa Barbara and his Ph.D. from the University of Washington, Seattle. After completing post-doctoral work at the University of Maryland, Baltimore and Tulane University, Dr. Snow took a position working on the use of GPS for flight-testing at Interstate Electronics Corporation (IEC) in Anaheim, Calif., in 1985. In 1991, Dr. Snow took the position of vice president of Allen Osborne Associates, Inc. (AOA) in Westlake Village, Calif.

There he worked on using GPS for precise timing and for geodetic reference stations. In 1997 he became Director of Marketing for Ashtech, Inc., and then for Ashtech Precision Products after Ashtech merged with Magellan Corporation. He is currently Director of Sales and Marketing for North, Central and South America for Thales Navigation in Santa Clara, Calif.

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