

The Economics And Implementation Of One Person Survey Operations Using Robotics

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About the Author

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Dean D. Exline PLS is vice president and co-founder of The HydEx Group, LLC. HydEx, formed in 2004 as a professional training company. Based in Wilmington, North Carolina with trainers in Florida and Ohio, it is a company founded on the principal of Professionals providing Professionals with quality training services in order to enhance their knowledge of the profession.

He is also president, founder and co-owner of GeoInnovation, PC. Also based in Wilmington, North Carolina, GeoInnovation is a full service Professional Land Surveying firm that provides surveying services throughout the eastern US.

Exline holds an AS in Civil Engineering from Shawnee State University in Portsmouth, Ohio and attended Franklin University in Columbus, Ohio where he studied Business Administration. He is registered as a Professional Land Surveyor in North Carolina, South Carolina, Virginia, West Virginia, Kentucky, Ohio, Idaho, Alabama and the US Virgin Islands. His background includes extensive experience in boundary, GPS and conventional survey control, dam deformation measurements, topographic surveys, small hydrographic surveys, coal pile quantity surveys, and power line surveys.

A user of Robotic technology since its inception, he is registered as a Professional Land Surveyor in North Carolina, South Carolina, Virginia, West Virginia, Kentucky, Ohio, Idaho, Alabama and the US Virgin Islands. His background includes extensive experience in boundary, GPS and conventional survey control, dam deformation measurements, topographic surveys, small hydrographic surveys, coal pile quantity surveys, and power line surveys.

He has authored and presented technical papers on the use and economics of robotic surveying at the ACSM Convention in Portland, Oregon in 1999 and FIG/ACSM in Washington, DC in 2002. He has also authored technical papers in the use of GPS to perform dam deformation measurements on large concrete and earthen dams.

Introduction

Robotic surveying technology is a very useful tool that, until recently has been extremely underutilized throughout the industry. This booklet will outline the advantages, procedures and economics of utilizing robotics in the daily operation of a survey company or department and make recommendations on survey equipment and options selection.

When robotic survey instruments came to the forefront in the early 1990's they were expensive and rare. But, like all things electronic, the cost has been reduced dramatically and the use of robotics in surveying has grown considerably. Even though the cost of this equipment has been reduced, most surveyors still get sticker shock when pricing the equipment. Hopefully the information contained herein will help remove the sticker shock barrier and get your firm onto the road toward the use of robotic technology.

The process of employing robotics, as any other major business decision, does not happen overnight. The decision to implement robotic technology is a multi-step process that requires, at times, some tough decisions, but in the end it will be worth it and your business will profit from it.

Section 1 - Decisions

It has been said time and time again, that the first order of business in any endeavor is Customer Service, we hear it every day in the mass media. Actually, making a profit is the most important issue on the plate of any business. Customer Service does come in at a very close second, but if you cannot make money, customer service and keeping the client happy becomes irrelevant.

As a result, the professional surveyor, whether a sole proprietorship, owner of a small firm or manager of a department for a Fortune 500 company, must make the proper decisions related to personnel and equipment mix in a manner consistent with the maximization of that profit margin.

The use of robotics, sound field procedures and properly selected personnel can provide a mix that will maximize the profitability of any given survey crew and in turn, the department or company.

Section 2 - Economics of Robotics

On the surface and at first glance, the cost of implementing Robotics into an organization looks to be an expensive and daunting task. In all

actuality, given all of the options available, the cost over the long term is considerably lower than with conventional crews.

Sticker Shock

The cost of equipping a conventional two person crew with a three second instrument and accessories is somewhere around \$10,000 to \$12,000. Sounds reasonable enough, right? The cost of equipping a one person crew with a three second robotic instrument and accessories is somewhere around \$30,000 to \$35,000. Sounds outrageous, right? Not exactly if you look at the benefits of robotics and how they may fit into long term goals of the company.

Unfortunately, this is where a majority of surveying professionals and other powers-to-be drop out of the robotic surveying track instead of looking deeper into how to implement it and make it work. Sticker Shock takes over and a potential opportunity is gone.

1. Conventional Versus Robotics Scenarios

Labor is the most expensive part of the overhead in most organizations. The use of robotics reduces the organizational overhead and can ultimately lead to a higher profit margin.

In order to compare the cost of labor versus technology, lets assume the following:

a. Two-person crew, robotic versus conventional costs

ABC Survey Company has one survey crew. It is equipped with a three second total station and Steve is the Party Chief and Tom is the Rod Person. Steve makes \$16.00 per hour and Tom makes \$12.00. The effective multiplier for ABC is 1.5 to cover overhead, benefits, 401k match, FICA, etc.

i. Conventional Scenario

Steve and Tom have worked together for two years and have a good fieldwork procedure going and are efficient at what they do. For every hour that Steve and Tom are in the field collecting data or setting stakes on that new school construction project, boundary survey, topo, etc. they cost ABC about \$70.00 per hour or about \$560.00 per eight hour day (Table 1). If ABC charges \$75.00 per hour for a two-person crew, ABC makes about \$5.00 per hour or about \$40.00 per eight-hour day. This equates to an approximate 7% profit margin. Not too bad, but ABC can

do much better by making some changes in the way in which they do business.

ii. Robotic Scenario

Steve is given a robotic total station to perform the same work on the same projects outlined in the paragraph above. For every hour that Steve and the robotic total station are in the field collecting data or setting stakes on that new school construction project, boundary survey, topo, etc. they cost ABC about \$49.54 per hour or about \$396.32 per eight hour day (Table 1).

If ABC charges \$75.00 per hour for a two-person crew (Tom is one crew member and the robot is the other), ABC makes about \$25.46 per hour or about \$203.68 per eight-hour day. This equates to an approximate 51% profit margin.

At this point, a majority of professionals look at that profit margin and say “We can’t charge our clients that much, we will be gouging them!” or “We work on a cost plus basis and we will have to lower our prices!” Actually, neither statement is correct and neither is incorrect either.

Two Person Crew Scenarios					
Robotic Crew Scenario					
Crew Makeup	Wage (Hr)	Overhead	Cost per Hour	Cost per Year	Cost per Month
Party Chief	\$ 16.00	1.5	\$ 40.00	\$ 83,200.00	\$ 6,933.33
Robotic Total Station	\$ 4.77	1.0	\$ 9.54	\$ 19,833.33	\$ 1,652.78
Total cost per robotic crew			\$ 49.54	\$ 103,033.33	\$ 8,586.11
Conventional Crew Scenario					
Crew Makeup	Wage (Hr)	Overhead	Cost per Hour	Cost per Year	Cost per Month
Party Chief	\$ 16.00	1.5	\$ 40.00	\$ 83,200.00	\$ 6,933.33
Rod Person	\$ 12.00	1.5	\$ 30.00	\$ 62,400.00	\$ 5,200.00
Total cost per 2-person crew			\$ 70.00	\$ 145,600.00	\$ 12,133.33

Table 1 – Two-person crew, robotic versus conventional costs.

b. Three-person crew, robotic versus conventional costs

If the organization generally fields a three-person crew, only fielding two persons and using the robot as the third will enhance the profitability of

the crew. As in the example above, when the cost of labor is reduced, profitability goes up.

However, the profit margin on a three-person crew is lower than that of a two-person crew because the cost of labor for a second person is higher than the cost of a robot (Table 2).

In order to compare the cost of labor versus technology, lets assume the following:

ABC Survey Company has one three-person survey crew. It is equipped with a three second total station. Steve is the Party Chief, Tom is the Rod Person and Cindy is the brush cutter. Steve makes \$16.00 per hour, Tom makes \$12.00 and Cindy makes \$10.00 per hour. The effective multiplier for ABC is 1.5 to cover overhead, benefits, 401k match, FICA, etc.

i. Conventional Scenario

Steve, Tom and Cindy have worked together for three years and have a good fieldwork procedure going and are efficient at what they do. For every hour that Steve, Tom and Cindy are in the field collecting data or setting stakes on that new school construction project, boundary survey, topo, etc. they cost ABC about \$95.00 per hour or about \$760.00 per eight hour day (Table 2).

If ABC charges \$100.00 per hour for a three-person crew, ABC makes about \$5.00 per hour or about \$40.00 per eight-hour day. This equates to an approximate 5% profit margin. Again, not too bad, but can be improved by making some changes in the way in which they do business.

ii. Robotic Scenario

Steve and Cindy are given a robotic total station to perform the same work on the same projects outlined in the paragraph above. For every hour that Steve, Cindy and the robotic total station are in the field collecting data or setting stakes on that new school construction project, boundary survey, topo, etc. they cost ABC about \$79.54 per hour or about \$636.32 per eight hour day (Table 2). If ABC charges \$100.00 per hour for a three-person crew (Tom and Cindy are the first two crew members and the robot is the third), ABC makes about \$20.46 per hour or about \$163.68 per eight-hour day. This equates to an approximate 26% profit margin.

Three Person Crew Scenarios					
Robotic Crew Scenario					
Crew Makeup	Wage (Hr)	Overhead	Cost per Hour	Cost per Year	Cost per Month
Party Chief	\$ 16.00	1.5	\$ 40.00	\$ 83,200.00	\$ 6,933.33
Rod Person	\$ 12.00	1.5	\$ 30.00	\$ 62,400.00	\$ 5,200.00
Robotic Total Station	\$ 4.77	1.0	\$ 9.54	\$ 19,833.33	\$ 1,652.78
Total cost per robotic crew			\$ 79.54	\$ 165,433.33	\$ 13,786.11
Conventional Crew Scenario					
Crew Makeup	Wage (Hr)	Overhead	Cost per Hour	Cost per Year	Cost per Month
Party Chief	\$ 16.00	1.5	\$ 40.00	\$ 83,200.00	\$ 6,933.33
Rod Person	\$ 12.00	1.5	\$ 30.00	\$ 62,400.00	\$ 5,200.00
Brush Cutter	\$ 10.00	1.5	\$ 25.00	\$ 52,000.00	\$ 4,333.33
Total cost per 3-person crew			\$ 95.00	\$ 197,600.00	\$ 16,466.67

Table 2 - Three-person crew, robotic versus conventional costs.

2. Money Talks

If your organization is squeaking by on a few dollars profit and you do not offer the staff much in the way of benefits, this extra money is your ticket to better employees through better wages and benefits. Give some of that money back to the robotic operator in a spot bonus, raise the wage 10 percent, offer more benefits, etc.

This extra margin also adds considerable flexibility to your billing options as well. If you have a good client and want to enhance your professional relationship, surprise the client with a 10 percent discount at the end of the month. He will be happy and you will still make money.

3. What about Tom?

Tom seems to be the one that takes the hit in all of this. As was stated earlier, some tough decisions may need to be made and in this case Tom was the one that did not make the cut.

However, if Tom is a good employee and works well in a decision-making role, maybe it is time to offer him a promotion to Robotic Party Chief and add another crew to your organization. The analysis of the organization and staff will provide pertinent information for this determination.

There are some tough decisions that will need to be made in order to implement robotics into an organization. In the scenarios presented

herein, Tom is a model employee that is always there when you need him and never misses any work. Maybe he is the one that you need to keep and you shed some other person that has been a burden to the organization by missing a lot of work, not being on time, causing errors, etc. This is why it is imperative that the following decision model be employed before any decision is made toward robotics.

Section 3 - Decision Model

The Decision Model associated with the process of Implementation of Robotics involves five separate and distinct steps prior to successfully utilizing it in your organization.

I. Evaluate Your Business Model - Look at the way you do business, asking honest questions about organizational goals and objectives to determine if robotics will fit into the organization. Review labor costs in this step.

You may need to return to this step after going through subsequent steps, but it is imperative that you perform this evaluation.

II. Evaluate Your Staff - This is something that you probably do on at least an annual basis, but this evaluation requires more detailed processes.

Every member of the staff (office AND field) must be evaluated to determine where existing staff members will fit into the organization after robotics are implemented. Again, honest evaluation of all aspects of each staff member will make implementation considerably easier. This is accomplished by evaluating every staff member on a scale of 1-10 on at least the following points: technical capabilities, work ethic, personal goal setting, tolerance for change, ability to work alone, ability to work in a team setting, punctuality, customer interaction, customer satisfaction, ability to learn new techniques, willingness to work overtime, etc. The list can go on and on, but this list will get you a pretty good picture of your employees.

III. Personnel Selection - After Step II above, you will have a better idea who is going to operate the equipment? As with any new equipment or process, there is a learning curve involved (discussed in Section 5 below). Proper selection of field staff will shorten that curve.

IV. Equipment Evaluation and Selection - Just as you did when you made the decision to buy your existing equipment, you need to evaluate all robotic models on the market to determine which one is most suited to your needs.

One item needs to be noted here. Evaluate the equipment in a real world situation. Don't let the salesperson show you a canned demo inside of your office unless that is where you do all of your work. Ask him to demonstrate the equipment in a typical work setting. If a considerable amount of your work is in the woods, ask that the equipment be demonstrated in the woods, work in traffic, same scenario, etc. Get a good feel for how it works prior to purchasing. Maybe a couple of visits are necessary from the salesperson.

V. Implementation - After you have proceeded through this decision model, it is time to implement Robotics into your organization. With the lessons learned here, chances are that you have selected the proper equipment and staff and this should go smoothly and profitability will improve dramatically.

Section 4 - The Stages of Learning the Skills

The Four Stages of Learning Skills - *The Learning Curve.*

1. INFORMATION, (Unconscious - Incompetent)

- You can't do what you don't know
- You must first have information
- Facts - knowledge
- This is the stage at which we start this, at the information level

2. AWKWARD (Conscious - Incompetent)

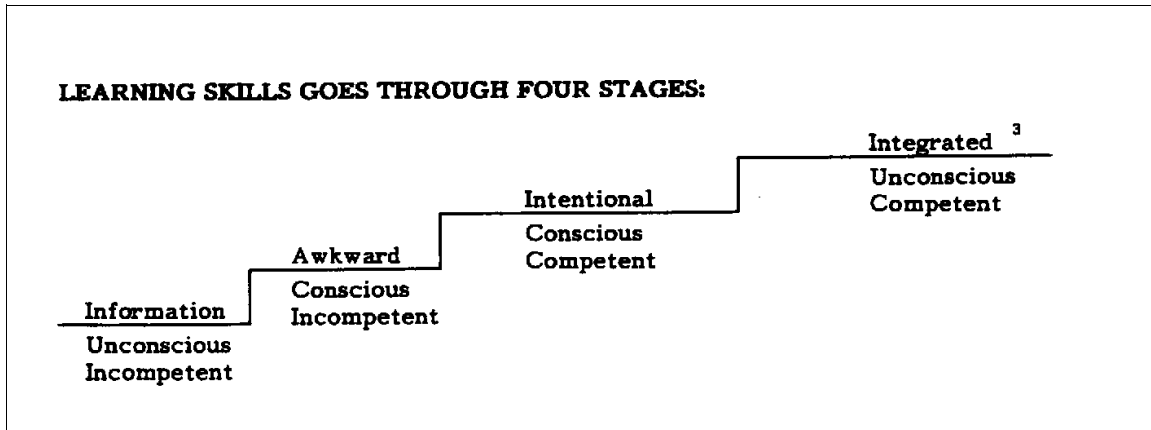
- You KNOW it, but you feel awkward as you try to do it
- This is the most painful stage of learning
- This stage brings up feelings of past failures
- This is the stage when we tend to give up

3. INTENTIONAL (Conscious - Competent)

- You can do it, but you have to think about it
- It is not natural yet
- You need practice (like music or sports)
- Longest stage in the learning process

4. INTEGRATED (Unconscious- Competent)

- You can do it without thinking about it
- Internalized
- It all falls together
- It is a part of your natural behavior
- Now it is difficult to unfix



Typing is a good illustration of learning a skill.

It takes lots of practice to integrate the skills. We have done this with the existing conventional total stations. Making the change from conventional equipment to Robotics should be a quick trip through these stages. You will need to practice these skills daily in order for them to make it into the Integrated Stage.

Section 5 - Pros and Cons

As with any procedure, there are pros and cons related to the use of robotics.

1. Pros

Lower Error Rates – Because all of the data is entered at the point of collection, there are fewer errors related to miscommunication between the rod person and instrument person.

Lower labor charges – One person can perform fieldwork in most cases.

It comes to work every day – properly maintained, it should give years of service.

No vacation pay required – it is always at the ready.

Doesn't complain – Although the operator may complain, there are no complaints from the “other” crewmember about hot or cold temperatures.

2. Cons

Safety in numbers – A second person may be required for some projects where safety is a concern. In those cases, you can place anyone with the robotic crew. There is very limited need for any training for that crewmember.

Brush cutting – In heavily overgrown areas, a brush cutter may be required. For a fee, a tree service will supply someone for that task if needed. In some cases, that person can be the second crewmember.

You can't lay it off – If business falls off for some reason, one option you may have would be selling. The other would be renting the instrument. Since the equipment rents for about \$2,000 to \$2,500 per month, this may turn out to be a pro.

Section 6 - Recommendations

Do Not Lower Your Fees

If anything, raise them. One of the first thoughts that may come to your mind is to lower rates because my overhead is less. Surveying is a professional service and should be treated as such. Make money for the firm and better yourself.

Visit Your Clients

As your are rolling this equipment out into your toolbox, make an appointment with each of your clients and inform them of what is going on and why you are doing what you are doing. The first thing that he is going to ask is “If you are only sending one person, do I get a better rate?” Tell him no. Just explain the efficiencies that he will be receiving in quicker and better service and he should walk away happy.

Don't Let It Set Still and Collect Dust

One thing that was found all too often was that people purchased the equipment and used it for a few weeks and put it in the corner and quit using it. There were various reasons (more excuses than reasons) given as to why this happened. It can be utilized for any surveying task and should be used everyday, not just for “special” occasions or tasks.

Get Training

Hire someone to train the field crews in the use of the equipment. Again, it will do anything that the conventional total station can do and should be used as such. By having someone (other than the salesperson) that has experience in the use of the equipment and procedures train you and

your personnel, the learning curve is shortened and your profit margin improves much quicker.

Patience and Determination

The first and foremost thing to remember when adding robotics (or any other new technology for that matter) is to have patience with both the equipment and the user. Whether that user is you or if you have someone operating the equipment for you, patience and determination are required. Do not let it get you down. Most likely the operator has considerable experience with conventional equipment and just needs to learn the ins and outs of robotic surveying.

Reflectorless Technology

One option that is recommended when robotic equipment is purchased is the addition of reflectorless technology for the equipment. It is invaluable for use by the field person(s) for collection of data on inaccessible points. It gives you the ability to shoot across a stream or ditch to shoot fence posts, trees, iron pins, and other pertinent data.

Backsight Setup

A second option that is recommended when purchasing is a backsight setup including a good quality tripod and tribrach. This comes in handy when working as a one-person crew to avoid walking so much.

Foresight Setup

A second setup like the backsight option is recommended for the same reason.

Tripod Carry Bags

The purchase of bags to carry the tripods in serves two purposes. It allows the robotic crewmember to carry the tripod more safely by slinging it over the shoulder and also protects the tripod from damage.

The instrument is likely going to be carried in some sort of backpack and you run out of hands and arms quickly.

Communications

Make sure that your field operator has some very reliable means of communication with you and others in case of some sort of emergency arises or just general communication about the project. I would

recommend investigating wide area two-way radio service or possibly Nextel Direct-Connect. Usually this service is less expensive than cellular and is much quicker to use if needed. You also have control over whom the field person talks to on your bill.

Conclusion

If you plan to implement robotics and one person crews into your organization, it is imperative that the entire organization be evaluated from top to bottom. This will allow for robotics to be properly inserted into the mix of equipment and personnel in an organization.

If you plan to implement robotics into your organization and continue to utilize conventional crew configurations, the organizational evaluation is still recommended, but maybe not as detailed. Again, proper organizational structure and equipment/personnel mix improves organizational efficiency and the bottom line.

When properly implemented, robotics can be a win-win situation for any organization.

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