

Swath Guidance Technology

by

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Widespread acceptance of new information technologies in agriculture may still be a long way off. But some producers and custom applicators are beginning to see how GPS can pay off in swath guidance applications.

Precision agriculture technology can be roughly divided into two distinct, but overlapping, categories. The first is the site-specific management process, a cycle of data acquisition, map creation and analysis, and site-specific management. Yield mapping, soil testing, crop scouting and variable rate application are part of that process. Swath guidance is the second category. Swath guidance involves the use of technology to assist in precision steering of application and other equipment. Both of these depend on the application of differential Global Positioning System (dGPS) receivers, embedded controllers and other information technologies (IT).

Although much research is underway, the profitability of site-specific management is still in question. The profitability of swath guidance, on the other hand, is easier to see. The ability to accurately steer various types of equipment across a field at relatively high speed, and with negligible overlap or skip, ensures efficient use of inputs, fuel and manpower. Producers, and to an even

greater extent, custom applicators have recognised this. As a result, swath guidance systems are beginning to pop up throughout western Canada, an area traditionally slow to adopt new technologies.

But reluctance to adopt these new technologies is only partly due to questions about profitability. These days producers have a lot on their 'plate' with all the other changes occurring in agriculture. The learning curve associated with GPS, computers and software can be somewhat daunting to the uninitiated. Fortunately, the people who manufacture and sell swath guidance products have done a pretty good job of making that learning curve manageable to those who can see the potential. An introduction to the technology and the leading players in the market follows...

Swath Guidance Technology

Swath guidance is a relatively simple process which uses some fairly sophisticated technology. The purpose of the system is to enhance the equipment operator's ability to drive parallel swaths while maintaining minimal overlap or skip and at the same time maximize speed. This is particularly important for large farming operations and custom applicators where large acreages must be covered within a limited time.

Swath guidance systems make this possible since equipment can be operated at relatively high speeds at night or in dusty or foggy conditions. Manufacturers claim that studies have proven that GPS-based swath guidance systems significantly out-perform other methods such as foam markers especially under less than ideal conditions.

GPS and Differential Corrections

Global positioning technology is at the centre of swath guidance. By now most of us have heard about GPS but, for the uninitiated, a brief explanation follows.

A GPS receiver is an electronic radio receiver with its own embedded controller (a simple, dedicated microcomputer) that can determine its position and elevation anywhere on the surface of the earth. In order to determine its position the receiver must pick up radio signals from at least four global positioning satellites orbiting the earth. The NAVSTAR GPS system includes a constellation of 24 satellites in spaced polar orbits. At any given moment at least 8, and as many as 12 satellites are in position overhead. These satellites transmit very precise timing and orbital position information that allows the receiver to calculate its distance from each one of them.

From these distances the receiver calculates its geographic position in latitude, longitude and elevation. For several reasons the accuracy of this position calculation is limited to about 100 meters (300 feet), not good enough for swath guidance applications. To increase the receiver's accuracy additional data, called differential correction data, must be sent to it via another radio link.

Two main types of differential correction data are available: beacon corrections and satellite corrections. Beacon corrections are broadcast by land-based transmitters and have an effective radius of a few hundred kilometres. Good quality GPS receivers, coupled with beacon corrections can provide sub-meter accuracy within about 100 km of the beacon. As distance increases, accuracy decreases at a rate of about 1 meter per 100 km of distance. Beacon corrections are available at no cost from Coast Guard stations in coastal areas and along major waterways. Not surprisingly, Coast Guard beacons are not available in western Canada. Beacon corrections are available, however, for a fee from at least one commercial source in western Canada, a company called Precision Signal. Their coverage extends across most of Alberta, Saskatchewan and Manitoba with acceptable accuracies in most areas.

Commercial corrections data is also available from geo-synchronous satellites in orbit around the earth. These are not the same satellites that provide the basic GPS timing signals. Geo-synchronous satellites are positioned in orbit in such a way that they remain in the same position above the earth all the time. From orbit the coverage 'footprint' of these satellites make corrections data available virtually anywhere in North America. Three main companies (Racal, Satloc and OmniStar) provide satellite corrections data for a yearly fee. When coupled with a good quality GPS, sub-meter position accuracy is consistent throughout the coverage area. Many vendors claim typical accuracies of 60 centimetres (2 feet).

To receive corrections data a GPS system must include, or be connected to, the appropriate radio receiver. Beacon receivers are different than satellite corrections receivers and may be standalone units or built into the GPS itself. Some manufacturers provide receivers for beacon and satellite corrections in the same package. This gives user the flexibility of changing corrections sources. Subscriptions for corrections data run in the range of about \$600 per year. A security code is provided by the corrections data provider which is entered into the receiver to unlock the data.

Swath Guidance System Components

All swath guidance systems incorporate an operator interface, or input/output device, to allow the user to configure and operate the system. This interface may be a keypad, touch-sensitive screen or push buttons on the guidance unit. A visual display of some type provides visual feedback. Some systems use a 'light-bar', while others use monochrome or colour video displays, similar to those used on notebook computers. A light-bar is an array of lights or alpha-numeric characters in a long, narrow enclosure which is mounted on the dash of the tractor. Using data from the GPS and the embedded controller, the display indicates the direction the operator must steer to stay on course. It may also display additional information such as speed, position and GPS receiver status. Video displays can display more information and in some cases turn the system into something that looks like a video game.

At the heart of any guidance system is the software which implements the its features. Features vary from manufacturer to manufacturer but typically the operator

interacts with the system in two ways: configuration of the system and operation of the system. In the configuration mode the system is told how it is to be operated. For example, the first step is usually to tell the system which type of distance units (metric or Imperial) will be used. This is usually simple to accomplish by moving through a menu system, pushing buttons or touching the screen. Next, the distance represented by each light in the lightbar is configured. On some systems the lightbar can be configured one of two way. One option allows the display to be set to indicate the direction and distance that the implement is off course. The other option set the display to indicate the distance and direction he must steer to get back on course. The choice depends on how the operator wants to think about what the display is showing him.

Before operating a swath guidance system a pattern of parallel swaths are set up in the controller's memory. Entering the implement width into the operator interface sets up the distance between swaths. All systems support straight back and forth guidance but some are designed to create swaths parallel to curved or spiral patterns. Back and forth guidance can be set up by indicating when the implement is at the beginning of the first row and then again when it reaches the end of that row. The computer simply calculates the coordinates of all parallel lines on either side at the width of the implement. Curve following is more complicated because the computer must store a series of points as the operator drives the initial pattern. The computer then calculates a series of points parallel to the first set.

The amount of overlap on each row is also configurable. For some swath guidance

applications it is important that no skip should ever occur but some overlap is acceptable. For example, if the accuracy of the GPS is sixty centimetres the only way to ensure no skip occurs is to configure the system to always overlap by sixty centimetres. For applications where the greatest efficiency is required, configuring for zero overlap will allow skip and overlap of up to the system accuracy to occur.

Some systems display the row number on the operator interface and keep track of which row the operator is on at all times. When the operator turns at the end of the field the computer automatically increments the row number and indicates the direction to steer to get started on the next row. If the operator wishes to skip rows and come back to them the system will allow that as well. This makes it easier to negotiate wide turns with large implements.

Features and capabilities vary from system to system. Some systems offer display features such as distances and acres completed, current heading in degrees, and cross-track error. Some systems provide faster position data updates than others. At higher implement speeds the number of position updates per second can be important.

The Players in Swath Guidance

Only a handful of companies are currently involved in agricultural GPS guidance applications. A brief overview of systems follows:

Springhill Engineering (formerly Ashtech) manufactures the AIM Navigator. This system is primarily a 486 computer system built into a industrial quality case with a

monochrome display and software in permanent memory. It can be used for a variety of precision agriculture tasks including navigation and guidance. Any dGPS receiver which provides standard NMEA0183 data can be connected to the computer.

Trimble is one of the biggest names in GPS receivers. Trimble's AgGPS Swathing Option is an add-on to their AgGPS132 dGPS receiver. The AgGPS132 is a combined GPS, satellite and beacon receiver. The Swathing Option adds a light bar and external keypad for configuration and operation. Trimble also markets a similar swath guidance system for aircraft. Check out www.trimble.com for an excellent source of agricultural applications of GPS.

Satloc's SwathStar III uses both a light-bar and a powerful field computer with colour flat screen display. The light-bar provides a steering display as well as alpha-numeric data such as heading and cross-track error. The colour screen gives a real time, two-dimensional graphic display of field coverage and swath pattern. Satloc also supplies a system for use in aircraft guidance. More information can be obtained from www.satloc.com

Cultiva Marker is a field computer with guidance software that can be used with any dGPS receiver which provides standard NMEA0183 position data. Although the company which originally introduced it has faded away, the product has re-emerged and is being distributed by Innotag out of Quebec. Marker is a unique product. It uses three-dimensional colour graphics instead of a light-bar. The operator steers the implement to keep the highway, stretching off into the distance, in the centre of the

screen. Other data is displayed around the edges of the screen. Go to www.cultiva.com for more information on this product.

Starlink's LB-3 Swath Path Guidance System incorporates the light-bar and controller in one enclosure. The light-bar shows alpha-numeric information as well as directional information on the same display.

All configuration and operation is accomplished through three pushbutton switches on top of the display. Like some of the other systems, it can be connected to any dGPS receiver which supplies standard NMEA0183 data. For more information go to www.starlinkdgps.com

Although there are lots of other GPS and precision agriculture manufacturers around,

significant contenders in the swath guidance market. Installation of the equipment is relatively simple and does not require any specialized tools or skills. Configuration can be accomplished in an hour or less and they all retain the configuration in non-volatile memory. Reports from the field indicate that although it takes some time to get used to using them, they make a big difference in the operators' ability to get the job done quickly and efficiently.

Prices for these systems (including dGPS) run in the range of XXXX. Some simple calculations will tell you if swath guidance can be profitable for you.