Selecting and Comparing Guidance Systems

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With the many options to choose from, selecting a GPS guidance system can be challenging. Should you buy an automatic steering system or a simple lightbar? What type of GPS correction signal is the best? What about GPS accuracy? Randy has evaluated dynamic GPS accuracy and different guidance systems. This session presents a checklist of questions to ask before purchasing a system.

GPS Guidance Systems

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With the increasing availability of GPS receivers and changes in farming practices the popularity of guidance systems is rising. The availability of free differential correction over a wider area has increased the number of lower priced DGPS receivers. As well, the increase in reduced and no-till acres has increased the importance of crop protection application and created challenges for producers to follow their desired path in the field. Crop stubble creates an environment where seeing the previous pass can be difficult. Several manufacturers have introduced GPS guidance systems to address these problems and several more will enter the market soon. GPS guidance systems rely on a satellite signal to indicate a vehicles location and indicate to the operator where he should be driving. Systems range from those that indicate a desired path to the operator via a display of lights or image to ones that automatically steer the vehicle.

Why GPS Guidance?

GPS guidance systems are intended to increase productivity by minimizing overlap and skips which could potentially reduce crop inputs such as chemicals and fertilizers, as well as other inputs such as fuel and time. They allow producers to operate in conditions that have historically been challenging. They can be used to extend operational hours for tillage, spraying, or planting while not increasing operator fatigue. In some cases a GPS guidance system can replace traditional marker systems such as foam or planter markers, while sometimes they are used to supplement traditional markers. Either way they can help improve driving accuracy in low visibility conditions such as night, dust, fog, or no-till stubble.

One of the best and often overlooked uses of a guidance system is to count rows when operating in a growing row crop. As you enter the turn rows and make your turn, the guidance system will lock onto the next swath to help you locate your next path through the field.

Compatibility

GPS guidance systems come in many shapes and forms and though they may initially be purchased for guidance only, they have many potential uses. The GPS portion of the guidance system can be used to provide position information for yield monitors, controllers, and data loggers. The GPS for a guidance system should provide the necessary flexibility to communicate with these other devices. This means the capability of providing a standard NMEA (National Marine Electronic Association) string output, usually a GGA and VTG string. The GGA string contains position and signal quality information and the VTG string contains speed information. These communication protocols have become agriculture industry standards. Newer GPS receivers have the ability to connect to a Controller Area Network (CAN), which is quickly becoming standard on all new ag vehicles. The CAN bus allows easy, reliable communication from all standard CAN devices regardless of manufacturer.

GPS Accuracy

Performance of a GPS receiver can be considered in two ways, accuracy and precision. Accuracy is defined by how well the receiver can locate itself on the face of the earth. This is more important when you want the capability to return to an exact location at some time in the future. Precision is determined by the consistency of the receiver. It is capable to be precise without being accurate.

Position Accuracy

Though there are no standard procedures or tests for measuring dynamic (moving) GPS accuracy. Furthermore, manufacturers typically use their own definitions of static accuracy. Though static accuracy may not be a good indicator of dynamic accuracy, most sub meter GPS receivers can be fairly precise for short periods. This short term precision aids guidance system performance.

Several recent studies have attempted to evaluate dynamic accuracy of current GPS technology. Though there is some variability in the results, DGPS receivers commonly used for guidance have pass-to-pass errors less than 10 inches. Some receivers have pass-to-pass errors lees than 6 inches.

In general, guidance systems can be broken into three categories based on GPS accuracy. A real time kinematic (RTK) GPS system is the most precise and accurate. They offer one-inch pass-to-pass precision and very repeatable accuracy. These systems are the most expensive and require a base station. They can achieve sub-inch accuracy. Multiple vehicles can use a signal from the same base station as long as they are within range of the radio signal. Operation requires line of sight so typical ranges of operation will vary with terrain, but are usually less than 6-8 miles. It is possible to set up repeater stations to extend the range of the radio signal.

The second category contains receivers capable of providing pass-to-pass accuracy less than 4 inches. These are general dual frequency DGPS receivers that require a subscription signal for differential correction. The cost of the signal varies with providers. Since there is no base station, these systems have a wider range of operation. Though the pass-to-pass precision is good, they are not as accurate or repeatable as RTK systems. However, advances in differential correction techniques are improving the accuracy.

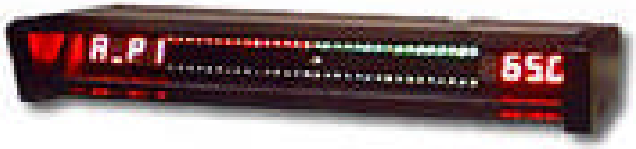
The third category offers pass-to-pass precision of about 8-10 inches. These are typically powered by GPS receivers that are using a single frequency differential correction from a subscription provider or the FAA's Wide Area Augmentation System (WAAS).

GPS Mounting Location

What about slope? Mounting the GPS antenna on the cab of a tractor or sprayer puts it 9-10 feet above the ground. This could possibly create problems when operating on contours. As long as slope is consistent, there won't be much problem since the receiver will always be indicating downhill. Antenna height becomes a problem when the slope is changing. For example, a pass is made on relatively level ground near a terrace and the next pass is made on the back for the terrace where there is more slope. The location of a GPS antenna relative to the center of the tread will be different for these two passes. The difference will depend on the antenna height and slope. This is inherent to all systems, unless they correct for slope, and the user should be aware of the operational characteristic.

Operator Interface

GPS accuracy is irrelevant if the operator cannot interpret the signal and make timely steering corrections. There are two basic types of operator interfaces for guidance systems. One uses an array of lights and the other uses an image. There are different configurations of each type and multiple ways to configure some units. Operators should find one that is easy to configure and interpret.



Light based systems, like the two shown above, use lights to indicate what the operator should do to maintain the desired path. Image based guidance systems, like the two below, use an image of the vehicle and an indication of where the vehicle should be relative to the desired path. Some may also incorporate audible commands to the operator. While determining which type is the most effective would be a challenging research project, operators can typically determine which one they prefer quickly.

Features and Abilities

The most common, and simplest, feature of most guidance systems is straight line guidance. The operator drives and logs a reference pass and the parallel passes of a preset swath width are created. The operator logs the reference pass by recording an A point at the beginning of the pass and a B point at the end. Each time the operator turns, the guidance system finds a new pass and indicates a steering pattern to follow this pass. In the straight guidance mode, all subsequent passes are typically referenced to the initial A-B line. The reference pass is typically place in a location that is easily driven in a straight line. This could be along a fence line or road. Straight line guidance can be conducted in back and forth or racetrack patterns.

Contour guidance is a feature of most systems. This feature allows the operator to drive a curved pass. At the end of the first pass, the guidance system creates a new pass parallel to the initial pass. Each subsequent pass is typically created parallel to the previous pass and not the initial pass. Though contour guidance may be a feature, it should be noted that it can be difficult

to use especially in the absence of other peripheral information such as terraces and other land features.

Most guidance systems also provide the ability to mark points in the field. This may be a location where application was stopped and you want to return to the point to resume. However, it may be difficult to use this feature if the system just indicates the distance and direction. The operator may not be able to take the most direct route and thus must learn how to use the information to find the point using another route.

Auto Steering

Automatic steering for agricultural tractors and sprayers has been accomplished with GPS systems. Initially these used only RTK GPS systems that were very accurate and precise. However in the last few years, systems that use less accurate GPS receivers have been introduced. The pass-to-pass precision of these less accurate systems is adequate for some field operations, but they may not be able to return to the same exact spot at some point in the future.

The key item to consider when selecting an auto steer system is accuracy of the GPS system. For example, RTK guidance may be more than you need for typical field tillage or maybe even spraying. However, the RTK system may be exactly what you need for planting row crops or strip tillage. Other features to consider are ease of use and the operator interface. The best thing to do is take a test drive before you purchase a system.