

# OPPORTUNITIES AND LIMITATIONS OF AUTOMATIC STEERING TECHNOLOGIES

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## Introduction

In the short span of 10 years we have gone from using the Global Positioning System (GPS) to locate ourselves in a farm field, to automatically steering a machine working in the field. This application requires about 15 components with each component evolving at a rapid pace. A number of companies have formed to provide automatic steering packages as aftermarket retrofits. At a slightly slower pace, the main equipment manufacturers are engineering machines that will be factory ready or factory equipped with automatic steering.

With the rapid advance in these technologies has come a variety of products with names including the terms “guide”, “trak”, “steer”, “pilot” and other related terms. The product names may be a source of confusion because they do not always distinguish between guidance applications and automatic steering applications.

For many custom applicators and farmers, the path through all the vendors and options they offer is simplified by determining how much precision and accuracy is required, tempered by the cost to attain the desired accuracy.

## Technology Components Required for Automatic Steering

Following is a breakdown of some of the components required for automatic steering applications. The Global Positioning System (GPS) is assumed to be available. Some of the components are commonly bundled together as a single product. For example it is not uncommon for a GPS receiver to be enabled to also receive a WASS or Coast Guard Beacon DGPS signal, and have a self-contained antenna. This bundling makes for a simpler installation, but may also limit upgradeability.

- GPS Receiver
- GPS Antenna
- Source for a Differential Correction Signal
- Receiver for DGPS
- DGPS Antenna
- RTK Base Station (optional)
- RTK Base Station antenna
- DMU (optional)
- Steering Control (Integrated or Mechanical)
- Wheel Angle Sensor (wheeled machines)
- Display Console
- Application Software (electronic control unit processor, ECU)

- Appropriate Wiring Harnesses

## Choose Components to Meet Your Application Needs

### Precision and Accuracy

For your equipment application do you need to be precise or accurate, or both? Accuracy is a measure of the departure from the true point. This is called static accuracy. Precision is the repeatability of the measurement. Vendors like to present pass-to-pass accuracy in the context of parallel tracking because in general pass-to-pass accuracy is 2 – 3 times more precise than static accuracy. In other words it is possible to be precise, but not be very close to the original true point.

If your application involves raising crops with sub surface drip tube irrigation, you need to be concerned with getting back to the same point time after time (static accuracy) and within a small window of error (precision). If your application is applying fertilizer with a spinner spreader where returning at a later date to the same location is of low importance, then pass to pass accuracy is probably an adequate measure to use in picking a GPS technology.

Strip tillage is an emerging practice and presents some opportunities for automatic steering. Or adoption of strip tillage might be accelerated with automatic steering. This practice involves disturbing the soil in a narrow band, usually in the fall, and also applying fertilizer in the same band. The following spring a new crop is planted in the tilled bands. If this is your application then static accuracy is very important. A current unanswered question is: “How precise to we need to be?” How many inches + or – of the tilled zone and fertilizer band is acceptable? If the GPS system static accuracy is acceptable, then the pass-to-pass accuracy is probably not a concern. Again, pass-to-pass is more precise than static accuracy.

### DGPS Options to Obtain Precision and Accuracy

Once you decide on the level of precision and accuracy required for your automatic steering application, the decision quickly narrows to DGPS options. Table 1 presents some typical options based on OmniSTAR satellite DGPS offerings and BEECON RTK. Generally higher accuracies come with higher costs. Satellite DGPS services require an annual subscription while base stations do not. Base stations have a high upfront cost.

WAAS is free but low accuracy limits its use in agriculture.

Table 1. Examples of DGPS correction accuracies.

DGPS Source	Classification	Static Accuracy	Pass to Pass Accuracy
WAAS (Wide Area Augmentation System)	Sub-meter	+/- 40 inches	+/- 8 - 10 inches
OmniSTAR VBS (L-band)	Sub-meter	+/- 24 inches	+/- 8 inches
OmniSTAR HP	Decimeter	+/- 4 inches	+/- 2 inches
BEECON RTK	Decimeter	+/- 4 inches	+/- 2 inches
BEECON RTK	Centimeter	+/- 1 inches	+/- 1 inches

### Dynamic Measurement Unit (DMU)

The DMU component measures pitch, roll and yaw. Given the position of the GPS receiver relative to the ground, a position error "d" (Figures 1 and 2.) occurs in sloping landscapes. If this error is not accounted for the automatic steering system will be off by the distance "d". The DMU may be offered only as an optional feature. If your application involves hills, then consider a 3 or 6 axis DMU as part of your automatic steering package.

Figure 1. Side hill position error.

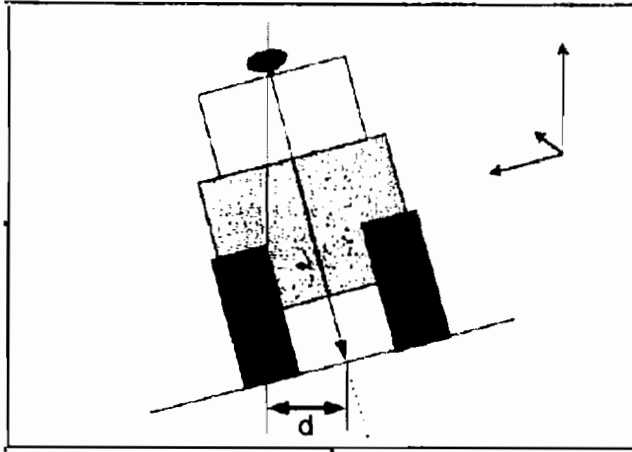
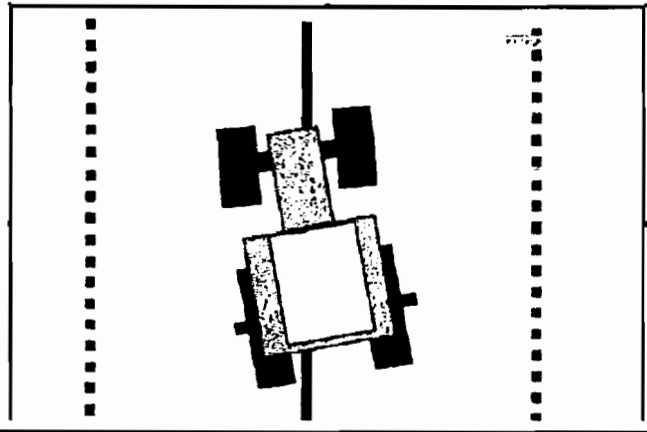


Figure 2. Side hill position error.



### Steering Control

Autosteer systems must be integrated with each particular machine's steering system. Availability of certain packages may be limited by the engineering required to complete this part of the installation.

Most applications interface with the hydraulic steering motor, or the motor is replaced with an electronically controlled version. This might result in more hydraulic hoses. One autosteer brand offers a mechanical device that attaches to the steering wheel. All autosteer systems must

be “tuned” with the steering control. The performance of the system may be affected by the machine ground speed.

Look for machine manufacturers to offer electronic steering control as a standard feature in the future.

### **Display Console**

Do you need another display box in the cab? If you are upgrading from a lightbar guidance system, you may be able to use the same display. Otherwise today you will need to make room in the cab.

This may be a short term inconvenience as the major equipment manufactures are now beginning to implement ISO standard VT displays with ISO standard Task Controller. What this means is that ISO compliant technologies should plug into a common network and display on a common screen. I speculate that multiple control boxes and displays will likely be replaced with a DVD player and other conveniences in the tractor cab to help pass the time in large fields.

## **Looking Ahead**

### **Upgradeability**

You may be sensing that technologies used in automatic steering systems are rapidly changing. It may not be realistic to expect after market autosteer components to transfer and work on newer machines. Check with your equipment dealer to learn about which autosteer brands or brand components are likely to be used in new equipment factory installations. This may help you maintain some value in your current or future autosteer technology purchases.

### **Factory Versus After Market**

As you make new machine purchases to update you fleet, expect to see automatic steering as a factory installed option. If you are not quite ready for this technology application, then look for machines that are factory ready for install at a later date at the local equipment dealership.

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