DGPS Guidance Systems in Agriculture

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John Deere Limited
Agenda

• Why Guidance?

• Types of Guidance system

• Accuracy & Correction types

• Guidance Benefits

• Advanced functions

• What can go wrong?
Why Guidance?

- Fast Easily Calculated payback
  - Reduced overlap
  - Increased field efficiency
  - Improved work quality
  - Reduced operator fatigue
  - And more…
  - Technology can be used for other applications – that may NOT be viable by themselves!
Guidance Application examples

- Fertilizer spreading in situations without tramlines

- Precisely spaced & Parallel lands with the combine

- Reducing overlap & increasing efficiency in tillage operations

- Accurate row or tramline spacing when drilling or planting
Types of Guidance system

- **Simple LED Lightbars**
  - Manual steering aid
  - Easy to setup and use
  - Fast payback on low initial outlay

- **Auto Steering assist**
  - Operate existing vehicle steering
  - Quickly switched between vehicles
  - Require adjustment for best result

- **Integrated Auto steer systems**
  - Highest accuracy
  - Tidier installation BUT not easy to switch to another platform
  - Higher initial outlay
Typical Auto steer components

- DGPS Receiver
- Driver interface
- “Resume” switch
- Steering Column sensor
- Wheel angle sensor
- E/H Steering Valve
- Steering controller
## What accuracy do you need?

<table>
<thead>
<tr>
<th>Signal</th>
<th>Accuracy</th>
<th>Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>EGNOS</td>
<td>+/-40cm</td>
<td>Broadcast spreading, Slurry &amp; lime spreading</td>
</tr>
<tr>
<td>Omnistar VBS StarFire 1</td>
<td>+/-30cm</td>
<td>Tillage operations, Spraying without tramlines</td>
</tr>
<tr>
<td>Omnistar XP/HP StarFire 2</td>
<td>+/-10cm</td>
<td>Harvesting, Mowing &amp; Seeding</td>
</tr>
<tr>
<td>RTK Network RTK</td>
<td>+/-2cm Repeatable</td>
<td>Vegetable planting &amp; hoeing, Bedding, Controlled Traffic Farming</td>
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</tbody>
</table>
Satellite corrections

- **Low accuracy (+/-40cm)**
  - EGNOS
  - Subscription free

- **Medium Accuracy (+/-30cm)**
  - SF1 / Omnistar VBS
  - Annual subscription £500+

- **High Accuracy (+/-10cm)**
  - SF2 / Omnistar HP+XP
  - Annual Subscription £750+

- **Pro:**
  - Wide availability

- **Cons:**
  - Satellite drift; Extended time for signal re-acquisition
Base station RTK

- Local correction calculation
  - NO SUBSCRIPTION
  - NO Satellite drift

- Correction supplied via VHF radio
  - Limited Range
  - Line of sight required

- Accuracy reduces with Range
  - Different base & rover horizons
  - +/- 2cm at 1Km from base
  - +/- 10cm at 20Km from base
Network RTK

“VRS or NTRIP”

- “Local correction calculated and supplied via network”
- On farm base station not required
  - Lower initial outlay
- No loss of accuracy at distance
- High subscription (£800 to £2000/yr)
- Good cell phone coverage is vital!

NTRIP server

Calculates correction signal

Raw data (correction data) from a pool of base stations across the country

Internet

Cell phone tower

Tractor gets the correction signal for its actual position

Tractor sends its position to central server

Tractor

HGCA
Tillage with Auto steer

Primary cultivation with 9530 tractor & 8m cultivator

<table>
<thead>
<tr>
<th></th>
<th>AutoTrac</th>
<th>without AutoTrac</th>
</tr>
</thead>
</table>

100% overlap
Overlap reduction

John Deere 7920 & 4m Simba Cultipress

Average Implement Overlap %

- Pass to Pass: 6.1%
- Lands: 10.5%

Source: Wood, 2005
Spraying with guidance

What about the financial benefits?
Overlap wastage reduced

John Deere 840i 33m sprayer
Roundup @5L - £21.25/Ha
11.73 Ha field
Increased Field Efficiency

- NO Reversing = faster turns!
- Cover the field quicker
- Save time, fuel & labour costs
- Simplified turning process

Miss Pass to Pass

A Time Wasted

Reversing on the headland!

Then Fill in
Work Rate with Auto steer

<table>
<thead>
<tr>
<th></th>
<th>Pass to pass</th>
<th>Lands</th>
</tr>
</thead>
<tbody>
<tr>
<td>Auto steer On</td>
<td>3.38</td>
<td>3.47</td>
</tr>
<tr>
<td>Auto steer Off</td>
<td>3.17</td>
<td>3.07</td>
</tr>
</tbody>
</table>

Source: Wood, 2005
Automatic Headland turning

• Combination of Auto steer & headland management
  • Higher Quality of work
  • Faster headland turns
  • Greater Input cost savings
    - Reduced headland overlap
  • Reduced Operator stress

• Relevant to many platforms
  • Tractors; Combines
  • SP sprayers
Passive Implement Guidance

- VEHICLE steered to put IMPLEMENT on correct track
  - Second receiver on the implement!

- Only really practical working with high accuracy systems (RTK)

- Useful crabbing elimination on slopes

- Increased line following in level land conditions also!
Implement guidance on level land

49.4% Improvement

<table>
<thead>
<tr>
<th></th>
<th>Implement Accuracy %</th>
</tr>
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<tbody>
<tr>
<td>Auto steer 25mm</td>
<td>18.9</td>
</tr>
<tr>
<td>Implement guidance 25mm</td>
<td>27.9</td>
</tr>
<tr>
<td>Auto steer 55mm</td>
<td>88.3</td>
</tr>
<tr>
<td>Implement guidance 55mm</td>
<td>94.8</td>
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</tbody>
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Strip Tillage
Planter
Active Implement Steering

- Steering the implement in addition to the tractor
  - Steering drawbars
  - Steering disc coulters
  - 3pt. Linkage sideshift
  - Plough steering

- Second DGPS receiver & steering equipment required – cost!

- Fits into high value cropping situations
  - Potatoes; Vegetables
Accurate receivers are not enough...

Auto steer system Performance

\[ \text{Signal Accuracy at Receiver} + \text{Vehicle Setup} + \text{Implement Factors} + \text{Field Conditions} \]

Only factor under manufacturer control
Shading & Interference

- **Shading**
  - **Trees & buildings**
    - Common issue – loss of Raw GPS
    - Avoid obstacles which cause shading
  - **Optimised software or “Glide” features**
    - “Guestimate” vehicle position
    - Drop down to lower accuracy

- **Interference**
  - Domestic / commercial satellite receivers? Rarely an issue
Setup factors

• **Implement**
  - **Width** – often set incorrectly!
  - **Offset** – many implements work “one-sided”
    - Drills, Mowers & Bedformers
    - Do 3 runs & measure the offset!

• **Steering sensitivity**
  - High speed – Low sensitivity
  - High draft – Higher sensitivity
    - Too high = twitching
    - Too Low = slow to adjust

• **Terrain Compensation**
  - Incorrect setup = Weaving
The Future?

• Leader - Follower
  • One (or more) vehicle tracks another
  • Direction & speed matched

• “Buddy” vehicles
  • One operator, multiple power units
  • Multi-pass operations

• Fast, reliable wireless communication between vehicles essential!
Summary

• **ALL** farms can benefit from guidance systems
  • Large, medium AND small farms can all make savings!

• **Low cost systems provide the biggest savings hit!**
  • Just buy one! You start saving as soon as you use it!

• **Buy the accuracy you need and no more**
  • Higher accuracy costs more, needs more setup and has more potential for problems!

• **Things can go wrong, but it’s worth working with the system to get them right**
  • Take care with setup! Drive to take account of obstacles.
Thank you