South Newton / Purdue AgBot

Kurt Vissering
Lucas Clifford
Alex Vitous
What is Agbot

The agBOT challenge was derived by Steve Gerrish to invoke the ideas and innovations of universities and entrepreneurs in the development of a fully autonomous corn planter.

The agBOT Challenge 2016 was a seeding competition with the following objectives:
- Produce an unmanned, device that will autonomously plant two or four rows
- Change seed variety and population per prescription
- Stream real time video front/rear
- Have the ability to dock and load two varieties of seed and starter fertilizer
- Planter functions
Our Plan

Large seed producers ship seed to smaller distributors via pro boxes

Each pro box will have a RFID code
Scanned by any user to transfer all seed details
 Tells the producer, distributor, and farmer where specific box is located
Information will be put into a large central database

http://twitter.com/GreatLakesSeed/status/666728023362772993

RFID will include variety, lot number, etc
Distributors “Real Time Delivery”

Local ag businesses and farmer relationships

With in 30-50 mile radius

-Farmers will be able to directly see where seed is located at any given time

-Used by farmers to accurately track how much seed of each variety their distributor has in its possession.

-The seed distributor can keep track of inventory towards the overall plan
Real Time Delivery System

Farmers tell distributors:
- which varieties
- when and where to deliver
- how much to deliver

Distributor will scan the RFID tag which will show the seed is located in the field.

This information can be stored in the central database to show other farmers the changing inventory of the distributor. This also benefits the farmer by eliminating the storage of large amounts of seed.
Benefits of Real Time Delivery System

Weather is unpredictable, and certain varieties only thrive in the conditions they are designed for. Distributors bring different varieties and amounts of seed to match up with the current weather conditions. One example of needing to change varieties could include cold, wet soils or dry conditions.
Part 2: Tracking and Loading Seed Details from the Tender to the Planter

The robotic planter will automatically scan the RFID to transfer the seed information to his planter monitor. Seed producers and distributors will also be able to see where each specific box of seed was planted with use of field maps. The planter will also be able to track the date and time of where each box is planted, as well as the weather and planting conditions.
Part 3: Tracking the Seed to Distribution in the Soil

The farmer will have a graphic map to show exactly where the seed varieties were planted in. Overlay tillage practices, fertilizer application, chemical application, fall yields, and rainfall with planting maps to see where varieties thrive. The farmer will also know the planting conditions as well as the time everything had been planted. This information will be transmitted to the seed producer in a central database if agreed upon.
Who Owns the Data?

The Farmer will own the Intellectual Property of his data

The farmer can make an agreement directly with his seed distributor and producer either for money or information collected from other farmers.
Information Learned from Data

The large data base will allow seed producers to research specific varieties based on information from all growers.

- Which varieties can be planted in wet soils
- Which varieties can be planted in colder soils
- Which varieties handle drought, flooding, and poor soils
- What tillage practices, fertilizer applications, and chemical applications are cost effective for each variety
NexAg – Increasing Efficiency/Increasing Profits

Developing a data driven Operation Center for scheduling and monitoring multiple AgBot autonomous planting units

Lowering asset and labor cost by coordinating real time applications and supply needs through ongoing real time data feeds monitoring distributor inventory, delivery of seeds/fertilizer, and autonomous planting equipment.
Key to Operation Center Concept Success

**Continuous data feed** changing variables and supplies algorithm information for human interface

24 hours

- AgBot Units
  - Acre planting rate
  - Seed/Fertilizer usage
  - Fuel/other machinery usage

- Logistic Supplier
  - Inventory allocation
  - Tender unit location (right place, right time)

- Weather (AgProflier)
  - Update hourly 2.5 kilometers
  - Current & predictive
  - Coordinated with soil moisture readings

48 hours

72 hours

This is only achievable with widespread broadband internet

Next Planting Solutions
Operation Center Data (screens and inputs/outputs)

**AgBot Units**
- Acre planting rate
- Seed/Fertilizer usage
- Fuel/other unit instruments

**Logistic Supplier**
- Inventory allocation
- Tender unit location

**Weather (AgProflier)**
- Update hourly 2.5 kilometers
- Current & predictive
- Coordinated with soil moisture readings

**RFID probox data record**
- Variety tracked inventory to field location (mapped)
- Tender distributor (right place right time)
- AgBot unit autonomous sent to correct loading location
- Loading data downloaded – (data fed into distributor for inventory update and correction for 24, 48, 72 hour plan)

**Soil moisture reading (Precision Planting) and predicted weather algorithms update 24, 48, 72 hour plan**
Economic Benefits
Increased Efficiency – Lower Cost – Increase Profits

Operation Center (Dispatch Driven)  24-48-72 Plan Driven

AgBot Units  (Estimated Costs)

Tractor
125 HP Tractor  $37 Hr rental rate
12 row planter = 15.3 a/c Hr ~ 1200 a/c season
Tractor cost planting ~ $2900  $2.42 a/c

Automation/Sensors
~ $15000  7 yr depreciation = $2150 yr
~ 1200 a/c = $ 1.79 a/c
$1.79 a/c

Planter 12 row
~ $75000  7 yr depreciation = $10700 yr
~1200 a/c = $8.92 a/c
$8.92 a/c

---------------

total  $13.13 a/c

Other cost reduction: AgBot unit standard tractor which can be cost utilized on many more functions. Purchased vs rental estimate.

Using existing production equipment keeps per acre cost down
Less development and new production costs
One dispatcher estimate handle 7 units
1200 a/c x 7 = 8400 a/c
Example: One unit non-operational – 6 units continue
Economic Benefits
Increased Efficiency – Lower Cost – Increase Profits

Operation Center (Dispatch Driven)  24-48-72 Plan Driven

Center Logistic (supplier) benefits  30-50 mile radius

Large seed producers ship seed to smaller distributors via pro boxes
RFID recorded delivery and planting – matched to field map
Inventory instantly updated – used for future decisions

Graphic map to show exactly where, and in which soil types the seed varieties were planted

Strengths and weaknesses of each variety recorded for future decisions.

Farmer owned information (IP) transmitted to the seed producer in a central data base

Decision:
With Operation Center control - AgBot autonomously park at coordinated place for loading tender to load AgBot unit

Simplified and allows tender operation to be at right time, right place to 24, 48, 72 hour plan

Allows flexibility in planting plans

Economic Benefits
Increased Efficiency – Lower Cost – Increase Profits

Operation Center (Dispatch Driven)  24-48-72 Plan Driven

Weather AgProflier Benefits

- The ability to compare actual planting plans against optimum planting windows.
- Continuous trending and comparison of actual planting progress to a schedule plan of 24 hours, 48 hours and 72 hours.
- Perpetual and automatic analysis of geo, farm, personnel, and equipment factors.
- Coordination of seed/fertilizer/chemical delivery with alternative changes in planting schedules.

AgProflier™ utilizes specific characteristics of Croston's demand planning and a new generation of Quality Function Deployment (QFD) in a proprietary Relational Mathematics model to compare actual planting schedules with ideal and marginal potential.

Improved use of prime planting windows through algorithm optimization of weather and other variables.
Economic Benefits
Increased Efficiency – Lower Cost – Increase Profits

Operation Center (Dispatch Driven)  24-48-72 Plan Driven

Operation Center

Operation Center Setup Costs (no facility cost)
~ $97,000  7 yr depreciation  ~$13,850 yr
example 8400 acres yr ~ $1.64 a/c
Service Charges (weather, data exchanges,
soil map interfaces, other) ~ $10,000 $1.19 a/c
Labor
Dispatcher  24 hour coverage
Planting (2 week period) ~$16,800 ($50 hr) $2.00 a/c
--------------
total $4.83 a/c

Benefits
Farmer owned data (IP) from all sensor and data inputs $ ????
Increase efficiency in meeting planting targets $ ????
Other industry studies demonstrate ~15%/20% + increase $????
Safety Improvement (less personnel interaction with equipment) $????
20/20 SeedSense controls, measures, and collects data on the following:

- Population
- Singulation
- Down Pressure
- Spacing
- Vacuum Pressure
- Loss per Acre

- Many farmers already own one
- Recognizable interface
- Individual row monitoring
- Can be viewed remotely with Field View
- Tractor telematics also remotely viewed (AFS Connect for Case IH)
Single Man Operation

- AgBots work ground ahead of planters (same exact system)
- AgBots plant autonomously
- Single farmer has ground station in a truck monitoring all AgBots
- Pulls up along field, tells which AgBot to refill, autonomous refilling occurs, then drives on to best location for the next AgBot when finished
- This allows single operator to return to farm/seed dealer for tender refill
Future Expandability

AgBots with 3 point mounted:
  Chemical/fertilizer applicators
  Tillage equipment
  Planters
  Forage equipment

One AgBot can be used for all purposes on the farm
Can be added to already owned tractors
Fabrication
Adjustable Pneumatic Closing Wheel
Assembly
Final Assembly
Replacing the Operator

- Uses LabVIEW as the control system software for easy code correction and adaptation
- National Instruments USB-6216 is the control interface that controls the following:
  - Linear actuators
    - Controlling the clutch, brakes, and throttle (both of them after we broke one)
  - Solenoid controllers for steering
  - Relay outputs for raising and lowering the planter
National Instruments USB-6216 (USB controller)
Automation Process
Heading to Agbot 2016

3 Blown tires later...
Low Technology Projects
Ag Leader Projects
That's all Folks!