


AgriControl 2016
 (Seattle, Washington)

Low-Cost Smart Tractor Control Options

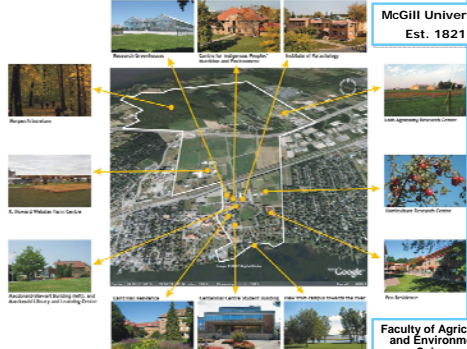
Viacheslav Adamchuk
Frederic Rene-Laforest
Antoine Pouliot
Trevor Stanhope
 Department of Bioresource Engineering
 McGill University

James Lenz
 Consultant
Philipp Münch
 European Technology Innovation Center
 John Deere


 August 15, 2016
 

Macdonald Campus

McGill University
 Est. 1821
 Faculty of Agricultural and Environmental Sciences



Research in areas: Precision Agriculture, Sustainable Agriculture, Robotics and Automation, and more.

Precision Agriculture and Sensor Systems Team

- Development of Proximal Soil and Plant Sensing Systems
- Geospatial Data Processing and Management
- Practical Implementation of Precision Agriculture

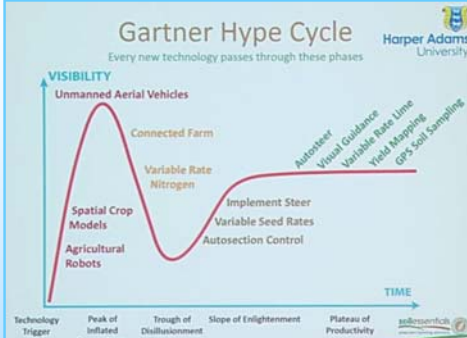


State of Adoption

Harper Adams University

Gartner Hype Cycle

Every new technology passes through these phases



Technology Trigger
Peak of Inflated Expectations
Trough of Disillusionment
Slope of Enlightenment
Plateau of Productivity

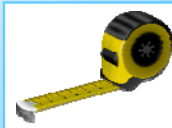

Technologies on the Slope of Enlightenment: Variable Rate Nitrogen, Implement Steer, Variable Seed Rates, Autosection Control.
Technologies on the Plateau of Productivity: Autonomous, Visual Guidance, Variable Rate Limb, Field Mapping, GPS Soil Sampling.

Technologies in the Trough of Disillusionment: Connected Farm, Variable Rate Nitrogen.
Technologies in the Peak of Inflated Expectations: Unmanned Aerial Vehicles, Spatial Crop Models, Agricultural Robots.

Simon Blackmore

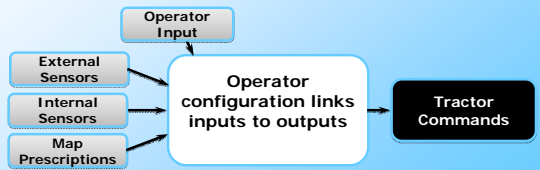
Two-Level Control

- Advisory service to define site-specific needs
 - Cultivar and soil
 - Weather and economics
 - Risk management
- Variable rate technology
 - Distinct difference in site-specific needs
 - Means to recognize the variability
 - Responsive application tools

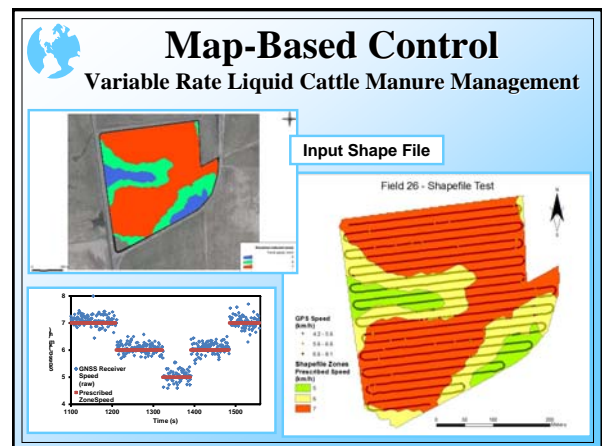
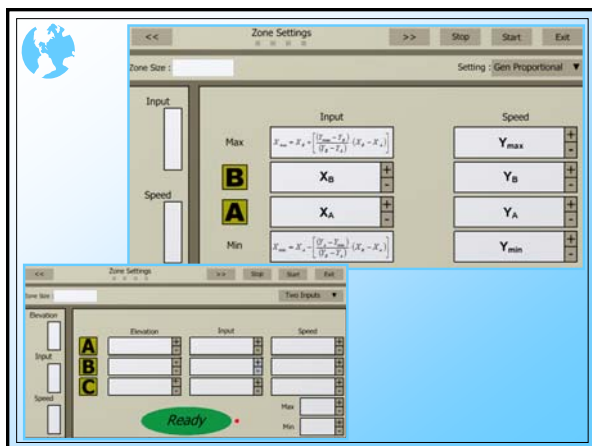
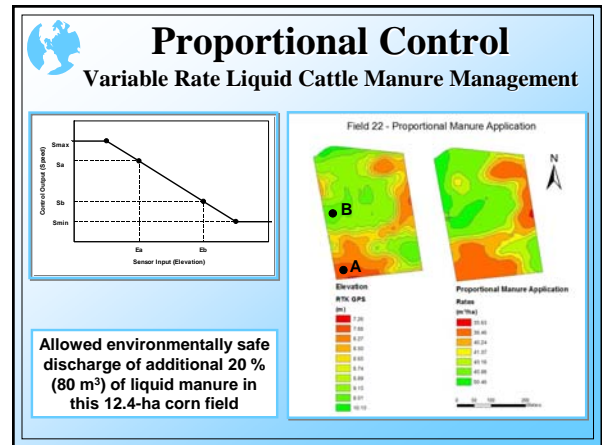
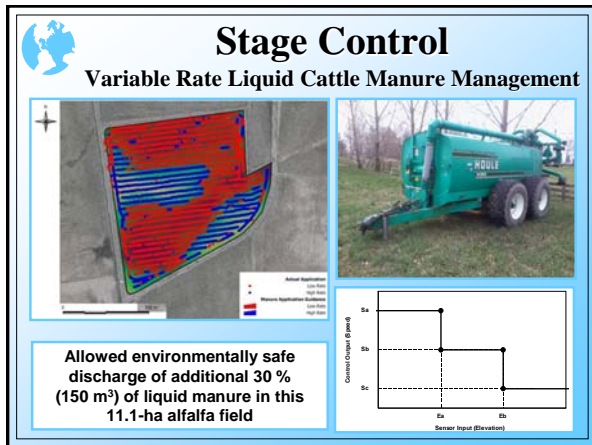
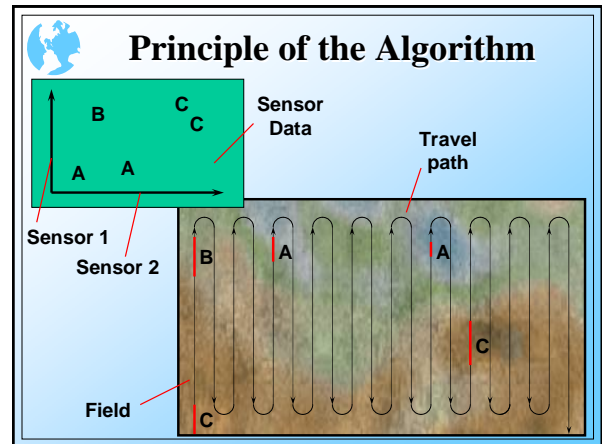
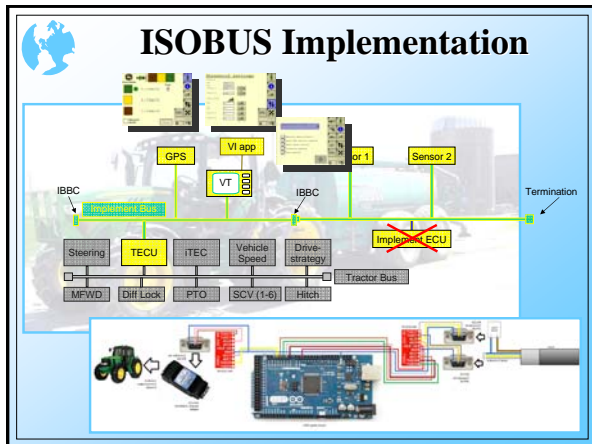
The Smart Tractor Concept

- Match tractor operation with local conditions according to operator-defined rules or direct operator input
- Use of internal or external sensors to replicate appropriate operation settings



```

    graph TD
      EI[Operator Input] --> OLI[Operator configuration links inputs to outputs]
      ES[External Sensors] --> OLI
      IS[Internal Sensors] --> OLI
      MP[Map Prescriptions] --> OLI
      OLI --> TC[Tractor Commands]
  
```



Variable Depth Planting

Planting Depth Control

Soil Water Content Sensing

New On-Line Soil Moisture Sensor

SE = 3.8%

Volumetric Soil Water Content (%)

Soil Water Sensor Index

- 02-Jan-14
- 03-Jan-14
- 09-Jan-14
- Lab Calibration

Sensor-Based Speed Control

Active crop canopy sensor

Normalized Difference Red Edge (NDRE) vegetation index

Poor vegetation

Strong vegetation

Ultrasonic proximity sensor

Crop height

Vegetation Index (NDRE)

Travel Speed, m/s

Time, s

Crop Height Tractor Speed Control

Tall vegetation

Short vegetation

Travel speed, m/s

Vegetation height, cm

Time, s

Speed (1.5x offset)

Vegetation height

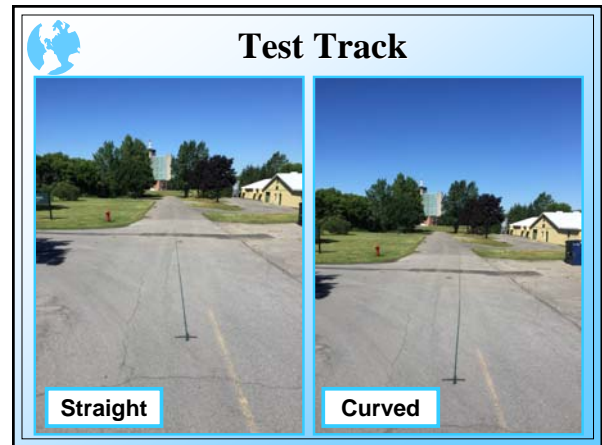
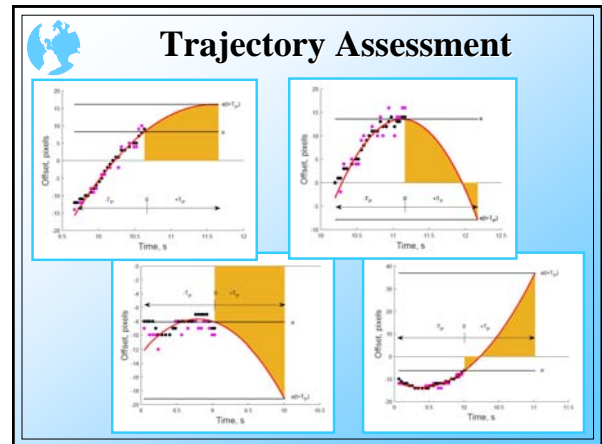
Machine Vision Cultivator Guidance

Height: 50 cm

+ 11 mm

Soy (10 cm)

Quick-Attach Steering Mechanism



Test Result

Trajectory	Direction of Travel	Speed (m/s)	Projection Time Length (frames)	Number of Runways	95th Percentile (cm)	Results with same letter are not significantly different
Straight	East-West	1	9	11930	7.9 ± 1.5	A B C
			21	11979	3.1 ± 1.5	A
		9	6476	11.1 ± 1.5	A B C D E F G	
	2	21	6544	8.1 ± 1.5	A B C D E	
		9	4316	15.3 ± 1.5	I J D E F G H	
		21	4397	19.5 ± 1.5	I J	
West-East	1	9	11950	8.7 ± 1.5	A B C	
		21	11825	3.4 ± 1.5	A	
		9	6652	9.0 ± 1.5	A B C D E F	
	2	21	4596	7.5 ± 1.5	A B C D	
		9	4395	14.7 ± 1.5	I J C D E F G H	
		21	4233	20.6 ± 1.5	I J	
Curved	East-West	1	9	12176	8.6 ± 1.5	A B C D E F
			21	11906	8.7 ± 1.5	A B
		9	6384	13.8 ± 1.5	I C D E F G H	
	2	21	6411	13.8 ± 1.5	I J C D E F G H	
		9	4550	16.0 ± 1.5	I J E F G H	
		21	4295	21.6 ± 1.5	J	
West-East	1	9	12883	7.1 ± 1.5	A B C	
		21	12991	3.5 ± 1.5	A	
		9	6061	11.7 ± 1.5	B C D E F G H	
	2	21	4095	13.4 ± 1.5	I C D E F G H	
		9	4237	16.6 ± 1.5	I J E F G H	
		21	4414	17.7 ± 1.5	I J G H	

