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Trends in Automated Farming

PNT Symposium

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What is Precision Ag?

- Precise Management of
  - Inputs (chemical, fertilizer, water)
  - Plant Environment (placement)
  - Processes
- Requires Spatial / Position data
  - examples to follow
- Managing a field through managing needs of individual plants and the environment in which they grow

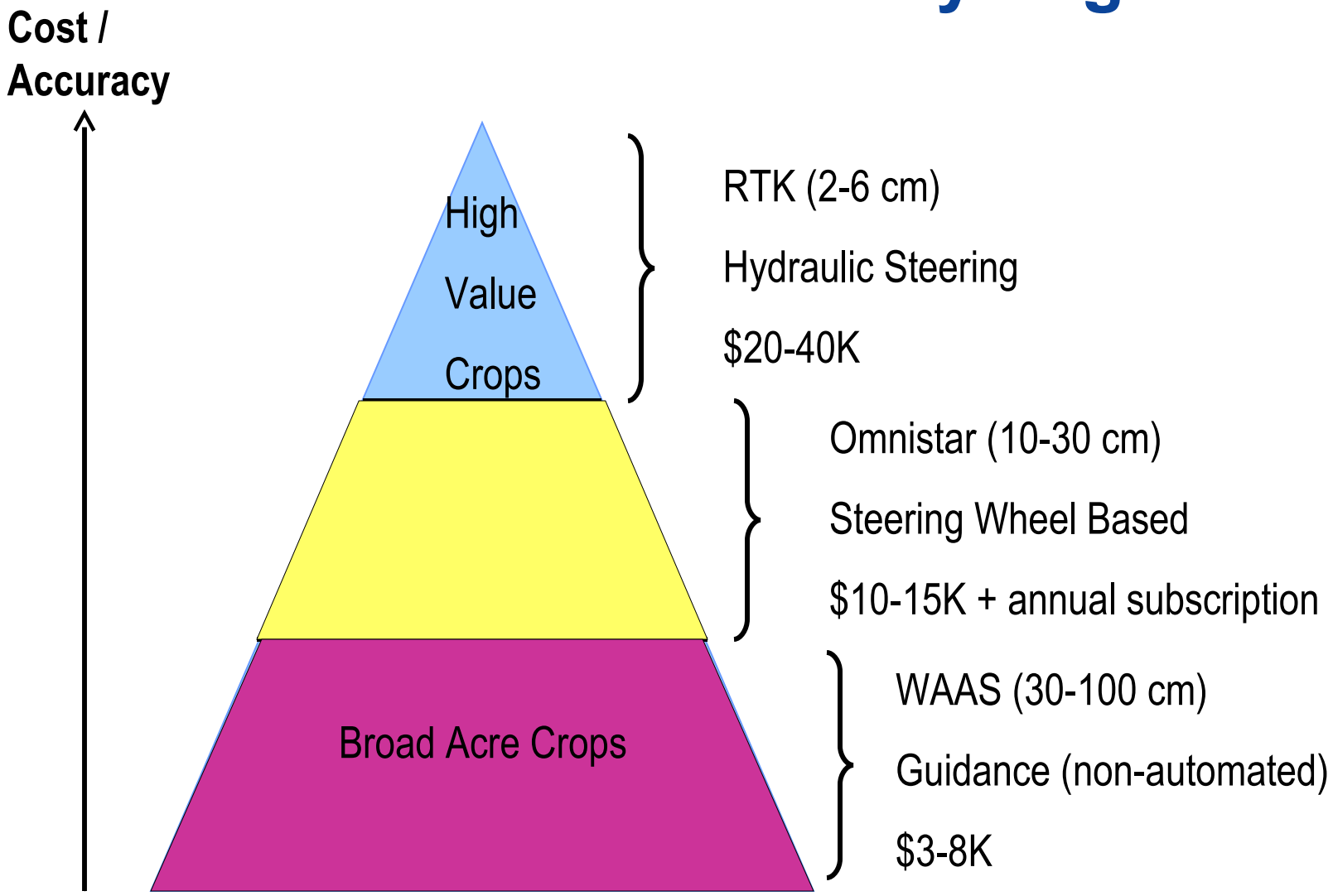
The AutoFarm Team

AUTOFARM
GPS Precision Farming

AutoFarm Today

- Founded by GPS research students from Stanford (1996)
- AutoFarm a Market Leader in Precision Hands-Free Vehicle Steering and Visual Guidance Products
- Customer Value Proposition
  - Runs day, night or in fog
  - No need for experienced drivers
  - Enables PRECISION farm practices
- AutoFarm Business Success
  - Over 12,000 units delivered
  - Worldwide distribution channel with over 600 dealers
  - 175 employees

Traditional Cost / Accuracy Segmentation



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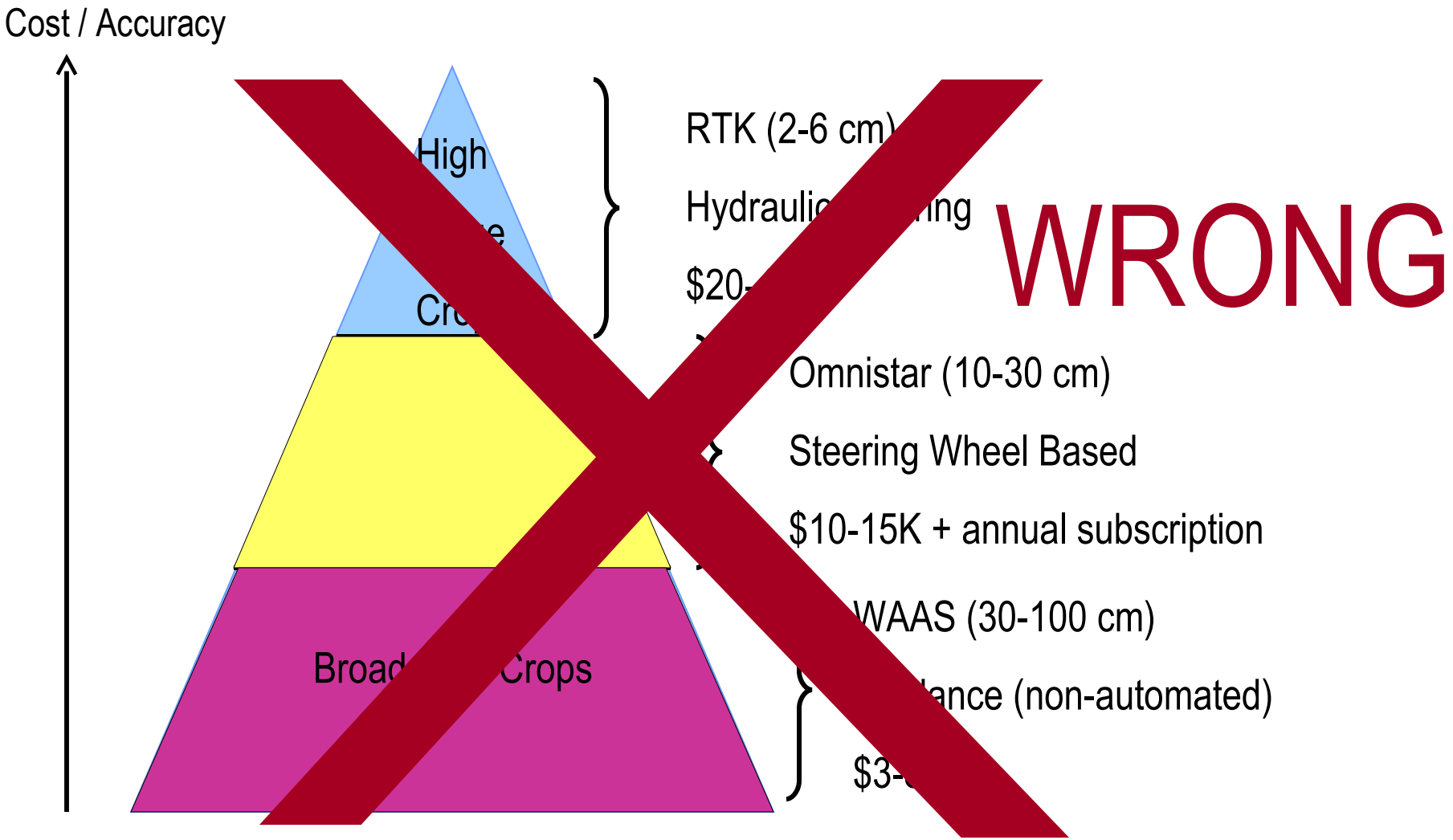
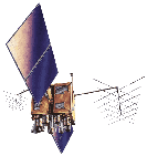


AutoFarm RTK AutoSteer System



Signal in Space

Roof Module

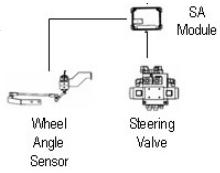
integrated with Multi-Antennal GPS Receiver

In Cab

Touchscreen Terminal

Vehicle Kit

Vehicle Specific



RTK Base Station

Network | On Vehicle

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The Technology Challenges

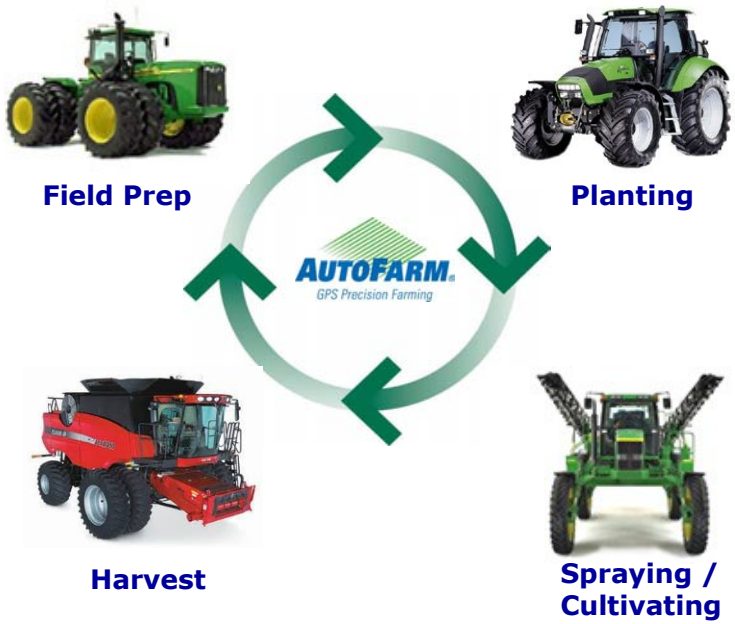
- RTK Navigation
  - continuity vs. accuracy
  - the usual suspects
- Communications
  - piecemeal solutions
  - latency, continuity
  - range
- Control Systems
  - easy calibration/setup
  - robust controllers
    - # target machines
    - wheeled,tracked,arti
    - terrain, soil conditions
- Managing System Complexity
  - features / complete solutions
  - software glue

Complex world of modern farmer

- Complex products and decisions
- Water Competition
- Farm Subsidies
- BioFuels
- International Policy (CAFTA, NAFTA)
- Commodities Prices
- Fuel/Fertilizer/Chemical Prices
- Climate Changes
- GMO's

Customer Call: It's not working

Agricultural Cycle

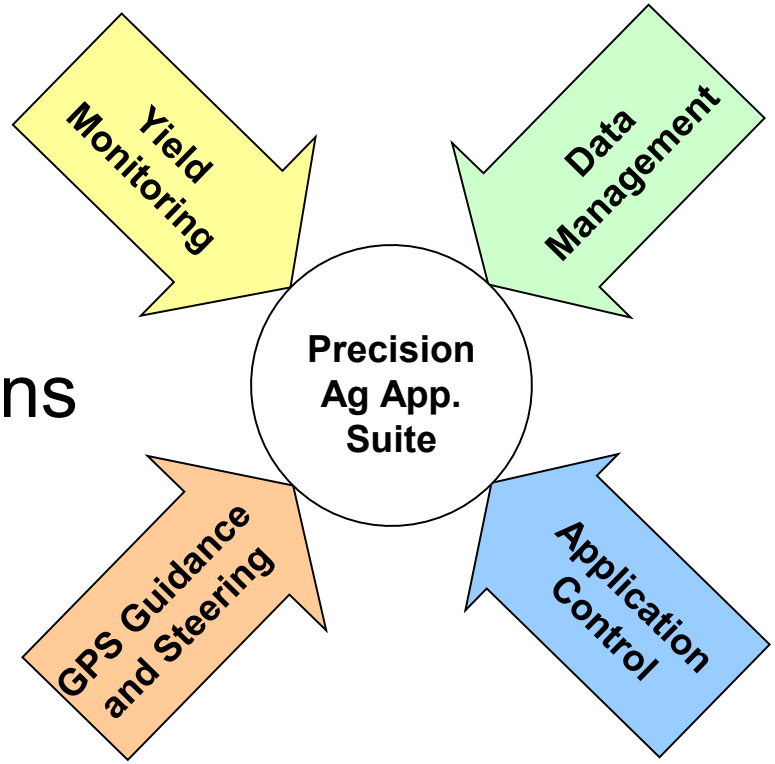


- AutoFarm system switches between vehicles in minutes, without tools
- Enables use on a variety of different machines and applications
- Farmer's Optimal Control Problem
  - Objective Function = profit
- Tractor is
  - sensor
  - actuator
- Challenge -- close the feedback loop with data
- Two way learning process

Cab integration and consolidation

Trend – moving toward Complete Solutions

- Today, piecemeal solutions
  - many vendors
- The industry is moving toward fully-integrated solutions



GPS Guidance and Steering is experiencing the fastest adoption of ANY technology in the history of agriculture

Does Precision Ag Pay?

- Single best investment that a farmer can make
  - There are no new acres overall
- Reduces / makes better use of inputs
- Increases yield
- Protects capital investment
- Raises the human to supervisory level
- Sustainable
  - Zero tillage (breaks down organic carbon)
  - Many parallels with organic farming practices

Inter row cropping -- better establishment

RTK with
Standing Stubble

Slashed stubble

Better Establishment

Sown in same field on the same day

Slashed stubble

Standing stubble

Reduced root disease by offsetting

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Inter Row Trials

Location	Treatment	Yield (t/ha)	Yield increase	Disease
Sandilands	inter-row	4.11	**6%**	Take-all
2004	in-row	3.88		
Tamworth	inter-row	2.51	**9%**	Crown rot
2004	in-row	2.3		
Sandilands	Inter-row	3.74	**9%**	CCN & Take-all
2005	in-row	3.42		
Hart	inter-row	2.99	**8%**	CCN
2005	in row	2.77		

The cost of selective herbicide overlap

- Average 20% yield decline due to double rate application
- Average 5% overlap of herbicide if not automated
- 5% of 20% is 1% of yield for every application of herbicide
- 3 - 5 applications per season

Strawberry bedding 1

Strawberry bedding 2

Strawberry bedding 3

Irrigation, over-fertilization, toxic-runoff

Precision Agriculture Summary

- The investment is cash positive in one year
- The rate of return is better than every other investment option available
- Precision Ag Is a Carbon Negative process
- Fixed carbon captures necessary trace elements
- Many similarities to “organic” farming – physical not chemical

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