NNI Sensor Workshop: The challenges in taking sensors from lab to machine

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Agenda

John Deere at a Glance

Sensor use in Agriculture

Challenges for on machine use

Case Study: Oil Condition Sensing

What’s Next

John Deere at a Glance

- **Headquarters:**
  Moline, Illinois, United States
- **Samuel R. Allen**
  CEO and chairman since 2010
- **Employees worldwide:**
  67,000
- **Total net sales and revenues:**
  $37.795B
- **Net income:**
  $3.357B
- **R&D**
  $1.477B
  → $5.7M each working day
- **Capital Investment**
  $1.158B

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John Deere's Solution Portfolio

- Agricultural Equipment
- Construction Equipment
- Turf Equipment
- Forestry Equipment
- Financial Services
- Power Systems
- Intelligent Solutions Group
- Worldwide Parts Services

Serving those linked to the land

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Phases of AG-Technology

Production System Progression

Category	Example
Integrated Solutions	
Intelligent Equipment	
Scale / Productivity	
Basic Mechanization	

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Sensors Developed by Evolution

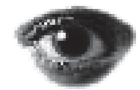
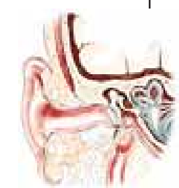
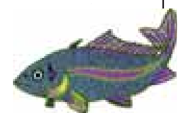
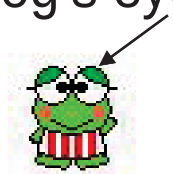
Motivations
:

Food

Survival

Quality of life

(safety and comfort)

Biological Sensor	Sensitivity
Sight (dark-adapted eye)	10 photons/sec-cm^2 
Infrared (snake) 	10^{-4} W/cm^2 @ 300 K
Acoustic (ear)	0.5-angstrom vibrations 
Electric field (fish) 	10^{-2} μV/m
Displacement (scorpion)	1 angstrom 
Smell (moth) 	1 molecule
Ultraviolet radiation (bird)	10^{10} photons/sec-cm^2 
Seismic (frog) 	1 micro-g
Magnetic (pigeon)	10^{-2} gauss 
Smart sensor (frog's eye) 	"On-chip" processing with algorithms for array processing, edge enhancement, and changing contrast

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Sensor Applications

Machine control:

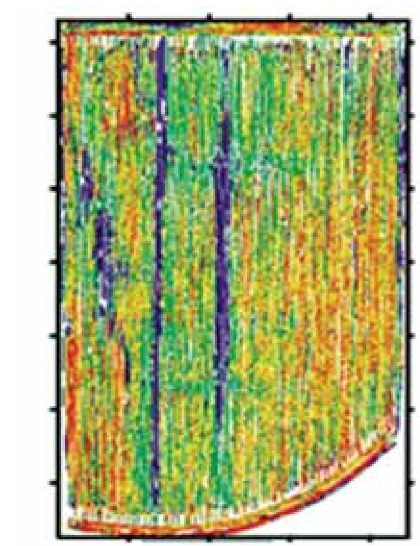
Pressure, position, speed

Sensing Machine Output:

Yield

Weight

Moisture



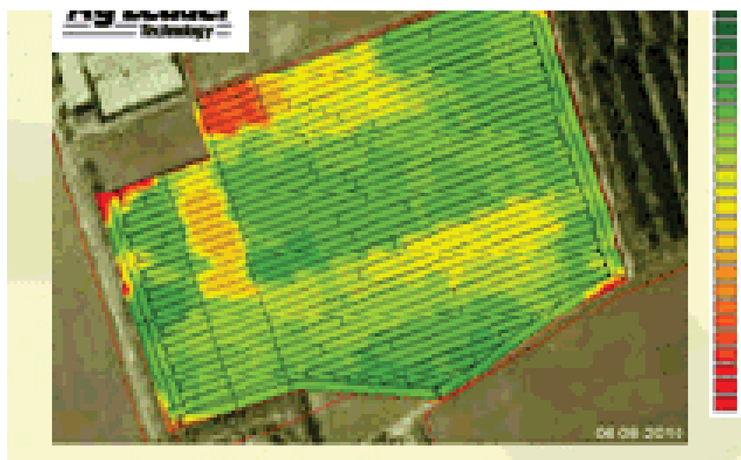
Sample collection:

Soil characteristics

Grain quality

Moisture

Oil Condition



How big is Ag Business for Sensing Needs?

Millions:

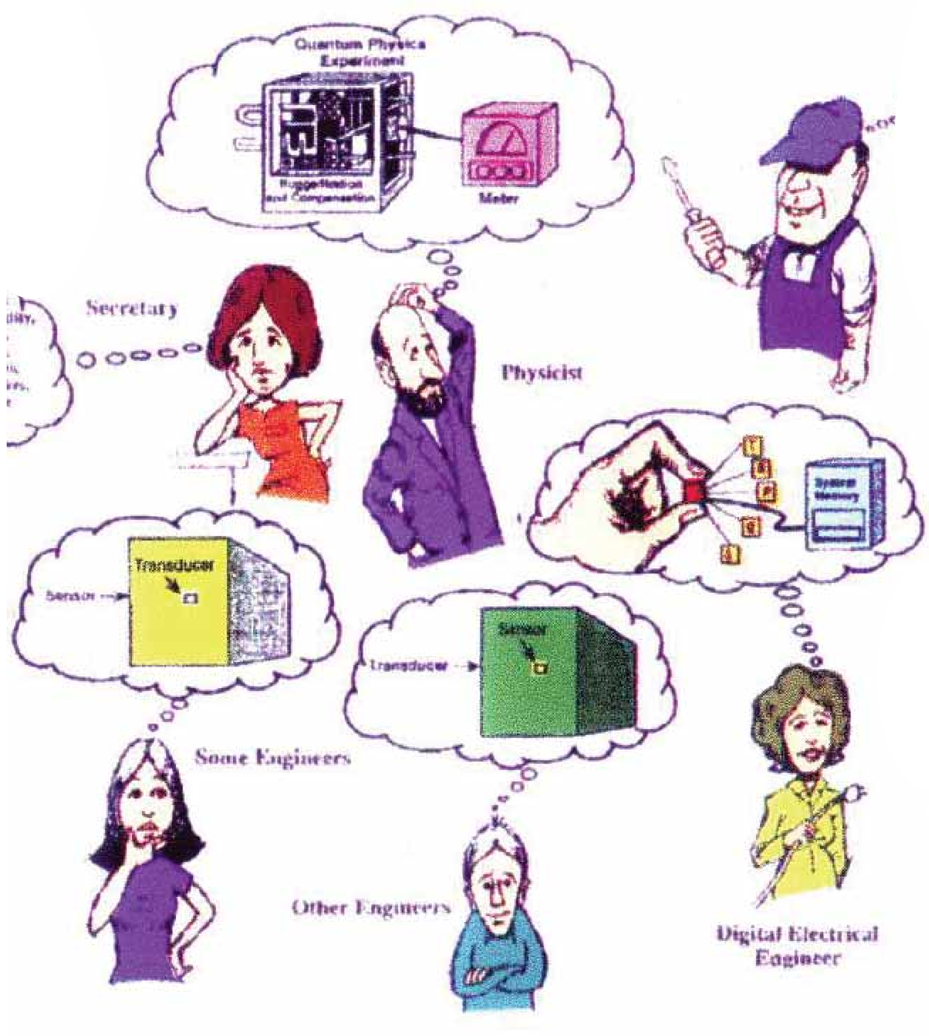
Machines, Farms

Billions:

Agronomic Zones

Trillions:

Plants



Challenges moving from lab to machines

The Environment

Obtaining a representative sample

Value Proposition

- **Accuracy versus cost**
- **Predicting customer value**

Component Availability

- **Supplier and technology**

Environment for on Machine sensors

Temperature

- Storage: -40C/+85C
- Operating: 0-70C

Vibration

Dust

Chemicals

Sampling challenges

Moving crop

Non – contacting preferred

Uniform sample

Videos of operations

Environment on and around the machine

Material flows for sampling

Sensors in use

https://www.youtube.com/watch?v=hqC_HhubyJM&feature=youtu.be

http://www.youtube.com/watch?v=C9g0q9QYe4Y

http://www.youtube.com/watch?v=Sxxf5lqzhi8

http://www.youtube.com/watch?v=5N-JzQOlN2M

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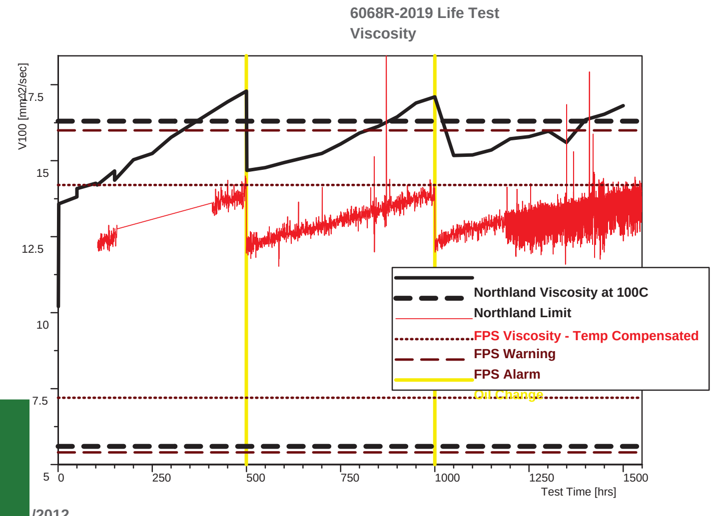
Case Study - Fluid Property Sensor

Year 1 Activities



Program Activities	Status
Component	Prototypes Lab measurements Plan production design
Application	Plan mounting locations Plan fluids
Customer Feature	Prognostics Extend change intervals Eliminate oil scanning

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Case Study - Fluid Property Sensor

Year 2 Activities

Program Activities	Status
Component	Production intent Verification tests and corrections
Application	Test on vehicle Resolve application issues Diagnostics
Customer Feature	Prognostics Extend change intervals Eliminate oil scanning

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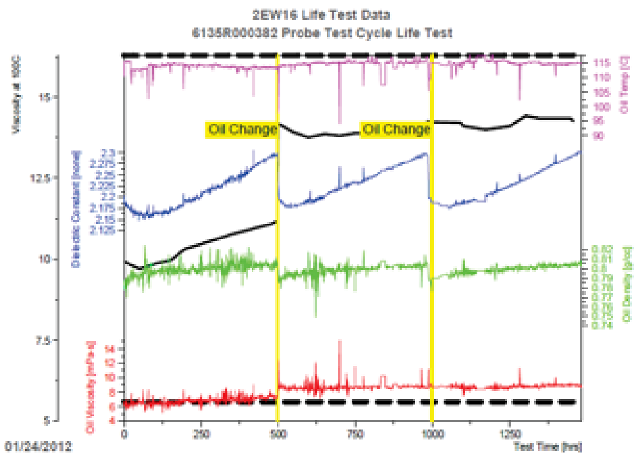
Case Study - Fluid Property Sensor

Year 3 Activities



Program Activities	Status
Component	Production ready
Application	Continue field testing
Customer Feature	Early warning for major issue Trigger oil scanning

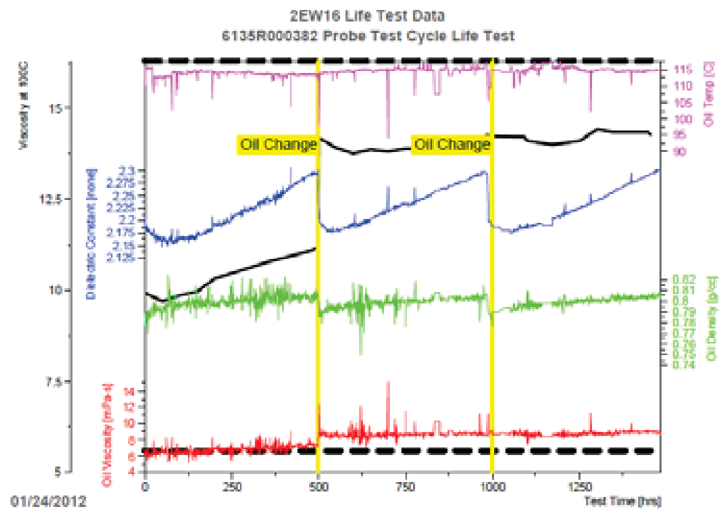
Case Study – Fluid Property Sensor

Year 4 Activities

Customer feedback –

Insufficient value, continue oil scanning

Re-evaluate sensor plans



Unique Opportunities Because of Nano

Remote sensing – eliminates sampling problem

More data points versus grid sampling

Opportunity to sense more parameters: constituents/chemistry

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What’s Next

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Thank You !