Increased Productivity and Sustainability in Agricultural Production Systems

MIT Conference on Systems Thinking for Contemporary Challenges
October 22-23, 2009

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Moline Technology Innovation Center
171 years of innovation have enabled John Deere to play a significant role in the productivity of the land.

There are significant productivity and sustainability challenges ahead:

- Population Growth, Food Demand, Water Availability, Climate Change, Global Growth

Systems Thinking and Systems Engineering:

- Have played a significant role in getting us to where we are today
- Are even more critical to meet the challenges of the future
Agenda

- John Deere Today
- Challenges Ahead
- Our Approach to Innovation
- Importance of a Systems Approach
Accelerating System Productivity for 150+ Years

Agricultural mechanization was one of the top 20 innovations of the 20th Century in US

- U.S. Population involved in agricultural production
  - 1848 – 90% of the population
  - 1900 – 38% of the population
  - 2009 – less than 0.9% today

Increased productivity through industrialization:

- **Mechanization**
- Genetics
- Chemicals
- Infrastructure
  - e.g., grain logistics systems
John Deere’s Mission is to Distinctively Serve Those Linked to the Land

**Vastly Global:** Customers and operations around the world

**Intensely Innovative:** Advanced robotics, navigation technologies and autonomous vehicles

**Vigilant Stewards:** Dedicated to our values, legacy, environment and safety of employees
172 Years of Innovation

John Deere Founded

1837
172 Years of Innovation

Motorization of the System

1837

1918
172 Years of Innovation

Integration of Systems Functions

1837

1918

1947
172 Years of Innovation

Operator Comfort and Convenience (Environmental Systems)
172 Years of Innovation

Automation of Machine Systems
John Deere Today – An American icon founded in 1837 and growing outside the United States for more than 50 years

- A world leader in providing advanced products and services for agriculture, forestry, construction, lawn and turf care, landscaping and irrigation
- A leading worldwide manufacturer of off-highway diesel engines
- One of the largest equipment finance companies in the U.S.
- Key investor in alternative energy sources
- Exciting new entities: John Deere Intelligent Solutions Group, Landscapes, Wind Energy, Water Technologies
Combination Harvester

Cutting, gathering, separating, cleaning, conveyance, and storage systems... optimized for harvesting grain
Serving Customers Needs Around the World

Emphasis on new agricultural products and emerging markets
- Brazil
- Russia
- India
- China
Globally Connected to the Land

The “culture” in agriculture relates to the diverse solutions that are used in food production, including the unique nature of specialty crops.
Automation to Increase Productivity

GPS Technology increasing productivity and reducing drudgery
John Deere Intelligent Solutions Group

Extending human capabilities through machine intelligence and information management

Enabling all John Deere Divisions to deliver integrated intelligent electronic and information-based worksite solutions to customers

- Navigation
- Documentation
- Communication
John Deere is found on every landscape
Renewable Energy Value Chain

Helping to establish sustainable, alternative energy sources

- Biodiesel from soybeans
- Ethanol from corn and sugar
- Agricultural waste products
- Biomass from forests
- Wind energy
Wind Energy Solutions
Water as a Reusable Resource

John Deere Water Technologies ...
3rd Largest Agricultural Irrigation Company in the World
Supporting solutions for world hunger

- KickStart – providing rudimentary farm tools for sub-Saharan African farmers, lifting more than 300,000 people out of poverty and hunger
Key Observations from a Systems Perspective

John Deere:

- Has proven through history that it is a part of customer solutions in the landscape, increasing the productivity and convenience of the solutions it provides its customers.
- Has a number of recent key components added to the toolset for providing systems solutions:
  - Machine electronics and controls leading to automation
  - Renewable energy in the form of wind energy and biofuels
  - Systems are driving connections across our historical businesses
  - Water is becoming a critical capability within the systems solutions
  - Sees the value of solutions at different ends of the scale
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Today’s Competitive Environment

- Competitive global environment
- Fast changing markets
- New business models
- Customer experience focus
- Increased complexity
- Technology innovation accelerating

These create challenges for the business, but also opportunities for growth through innovation.
Moving business downstream in the value chain

**Systems Productivity Opportunity**

<table>
<thead>
<tr>
<th>Market Size</th>
<th>Machine</th>
<th>Multiple Machine</th>
<th>Site</th>
<th>Processor</th>
<th>Consumer</th>
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<tbody>
<tr>
<td>Total Market</td>
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<td>Deere</td>
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Opportunity Space
Solving more of the customers problems

Avoiding commoditization requires growth beyond equipment

Diagram:

- Global Economy & Infrastructure
- National Economy & Infrastructure
- Local Economy & Infrastructure
- Farm
- Field
- Machine
Population Growth and Agriculture

Percentage of population engaged in agriculture

- U.S. 0.9%
- Western Europe 1.7%
- Former Soviet Union 6.8%
- Brazil 6.4%
- Argentina 3.7%
- India 25.4%
- China 38.5%

By 2050 there will be 6.3 Billion people
Expanding Global Economy

Growth in China and India

Dietary shifts with increased prosperity

- $1.25/day – 1.4 B people
- $2.50/day – 3.4 B people
  - Hunger is not a major issue
- $2-$10/day – Eat more meat, dairy products, fruit/veggies
  - Growth in Ag commodity demand
- $10/day – Buy more processed, packaged, luxury goods
Increased Energy Demand

Population Growth and Energy Use

Competition for Energy Resources

Other Energy Issues

- Clean Energy
- BioGas
- Waste to Fuel
- Feeding and Fueling
- Dedicated Energy Crops

![Population Growth and Energy Use Graph]

![Renewable Energy Diagram]
Climate Change Creates Impacts

Heavy storms
New regulations
Off-season rainfall patterns
Emergence of new invasive plant species
Drives mass migration
Temperate crops shifting to tropics
Water becomes as critical as fuel to meet the production demand

Agriculture uses 70% of the fresh water used in the world

• Average efficiency is less than 60%
• Rapid urbanization
• Competition for the use of water

World food production needs to double by 2050 using less water than today

• Biofuels will add further to this challenge
Understanding Our Production Capacity

Global production potential

Food transparency
  • Geo-coded food
  • In-depth analytics around food

Land use issues
  • Urban sprawl
  • Continued population migration from rural to urban
  • Dense intensive systems
  • Reforestation and Ag for carbon capture
  • Mechanization in China, India
  • Growth of Gardening
Sustainability on Every Landscape

Construction for emerging markets
Collapse of crop diversity
Recycle everything
Increasing soil carbon
Sustainability gets codified and certified
Politics and Culture

Colonization of developing countries for food production
Obesity and health impacts food production
Increased regulations
Mass boomer retirements
Aging populations in Europe, Russia, and Asia
# Digital Convergence is Changing Everything

## Technology Infrastructure
- Deep-web data mining
- On-demand supercomputing
- Robotics & Automated vehicles
- Pervasive broadband mobile computing
- Inexpensive sensor networks
- Stronger, lighter materials

## Explosion of Connectivity
- Rapidly improving communication technology
- Self-healing systems
- Automated Language translation
- Massive integrated databases
- Seamless information transfer

## Innovation
- Farmer social networks
- Collaboration everywhere
- Expanding network-centric innovation
- Speed of innovation triples
- Customers know what they want and demand it more forcefully
- Web 5.0
Systems Engineering

Intensely-integrated solutions
Systems thinking drives sustainable practices
Dense intensive sensing
Hyper-connected urban farming
Vertical farming
Health-driven agriculture
Agenda

John Deere Today

Challenges Ahead

Our Approach to Innovation

Importance of a Systems Approach
John Deere Was Founded On Innovation

Systems **innovation** is **critical** for our future growth.
Understanding Innovation

Innovation is the reward of the business execution of an idea that uniquely meets a customer need.

Business Processes

- Speed to Market
- Manage Risk
- 7% SVA Growth
- Revenue Growth

EPDP
BGP
OFP

Idea Driven

Strategy Driven

Market Trends

Customer Needs

Unmet Needs

Invention Space

Novel Technologies

Push

Pull

Technologies

Technology Trends

Business Processes

John Deere
John Deere’s Drive for Growth will Focus on Systems Approaches that Benefit Our Customers

“30/70 Innovative SVA Growth”

Guiding Principles

- Genuinely new offerings
- Entering new product/service markets
- Engaging new competitors
- Implementing new-to-the-industry ideas
- Bundling products, complementary services
- Meaningful innovative product enhancements

Systems approaches will be key drivers of new future growth to sustain our innovation demand
Innovation Spheres to Focus Accelerated Innovation

Understanding Global Change
• Driven by Megatrends

Understanding the Impact to Deere
• Growth opportunities (Platforms)
• Business threats

Innovation Spheres Define Aspirations for Growth
• Provides a common vision
• Sets organizational targets
• Addresses growth barriers
• Leadership driven and externally validated
Innovation Opportunity Spheres

- Machine Productivity
- Worksite Solutions
- Environmental Sustainability
- Connecting Land and Lifestyles
- Renewable Energy
- Water Management

Growing a Business as Great as our Products

Connecting Land and Lifestyles
MACHINE PRODUCTIVITY
Technology advances, access to information, and automation, enabling customers to work harder, faster, and smarter.

Breakthrough growth in machine productivity through automation:

- Automation of machine functions
- Coordination of machine-to-machine operations
- Increased levels of machine autonomy
WORKSITE SOLUTIONS
Breakthrough solutions to help our customers manage equipment, people, and time more effectively.

Moving from Breakthrough Machines to Breakthrough Solutions:

• Real-time optimization of worksite systems
• Information management and decision support
Differentiating our business through sustainable solutions:

- Solutions to respond to air quality regulations
- Increased efficiency through vehicle electrification and intelligent mobile equipment
Solutions to provide simplicity, flexibility and versatility:

- Systems that are easy to use by anyone to enrich the work experience
- Creating integrated solutions through task automation
Creating new businesses in renewable energy:

- Developing and managing wind energy solutions
- Optimizing solutions across the value chain (feedstocks, collection, provisioning, conversion, and use)

Provisioning solutions for biomass feedstocks
WATER MANAGEMENT
Utilizing an important reusable resource in an efficient manner.

- Efficient management and control in landscape environments
- Increasing the efficiency of agricultural use of water
- Agronomic solutions that conserve water

High efficiency irrigation technology
Agenda

John Deere Today

Challenges Ahead

Our Approach to Innovation

Importance of a Systems Approach
The Business Need

Need to increase pace and level of innovation to grow business

Increasing product complexity
  - Current technologies are rapidly advancing and challenges are mounting

New technologies are becoming viable: electronics, communications, etc.
  - Competitive advantage if able to effectively develop, integrate and deploy them

Technical competency to objectively select, design and verify products and services with John Deere non-traditional technologies

Increase effectiveness of business processes (e.g. product development)
  - Especially customer requirements capture and tracking

Career growth path for engineers who want to lead engineering
The Engineering Need

Reduce warranty claims caused by interfaces between subsystems
Reduce design iterations through clear requirements
Method to pass intellectual property from one tractor program to the next, even when people change
Required to deliver products globally
Goals of Systems Engineering Deployment

The elimination of campaigns/recalls
  • Product Improvement Programs (PIPs) at John Deere
A reduction in the number of physical design iterations
Successful integration of new technology into our products
Delighted John Deere customers due to exceeding their expectations (for the system)
It is all about Systems Approaches to Innovation

Front-End of Innovation
  • Understanding the dimensions of sustainable production systems
  • Ag System Value Chains
  • Customer Value Drivers

Engineering Solutions
  • Production Systems
  • Worksite Solutions
  • New Businesses
  • Responding to Environmental Regulations and Change
  • Creating Novel Solutions
Traditional Innovation vs. Front-End of Innovation

### Problem Identification
- Single Idea
- Technical Assessment
- Customer Validation
- Financial Opportunity

### Solution Development
- Opportunity Space
- Assess value chains, processes, and jobs
- Ideation sessions
- Alternative & Outliers
- Breakthrough gains

### Solution Evaluation
- Technical Assessment
- Customer Validation
- Financial Opportunity

### Solution Choice
- Go/No Go
- Prioritize opportunities
- Develop
Innovation using Value Chain Analysis and Systems Engineering

View the entire value chain as a “System of Systems”
Define system boundaries, inputs & outputs
Identify all stakeholders, their requirements, functions & interactions
Model value drivers and identify opportunities to add more
Create alternative solutions:
  • Products, processes & services
Select the best solutions: most profitable
Integrate solutions back into the “System of Systems”
Key Systems Engineering Practices

Focus on requirements
  • From many different stakeholders
Develop strategic solution architectures
  • Flexible, adaptable, sustainable
Explore many different alternatives
  • Select those that maximize utility
Integrate solutions from many providers
Verify and validate solutions to requirements
  • Again, from many different stakeholders
Conclusions

Agricultural systems are at the highest level of productivity we have ever known...

- But to meet future food demands, they will need to grow even more productive

Systems approaches have already created very productive machine systems

Future opportunities enabled by systems approaches:
- More as productive worksite solutions
- Renewable energy solutions that meet global energy demands
- Environmental sustainability driving new solutions that increase productivity in a sustainable way
- Production systems that include water as a resource constraint
Conclusion

• Growing demand for Systems Thinking and Systems Engineering