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Strategic Decision Making Under Uncertainty: Innovation and New Technology Introduction during Volatile Times[1]

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Abstract

This case study outlines the strategic, marketing, and organizational issues facing the farm machinery and equipment division of Deere and Company as it tries to continue to grow. Deere Ag Division is considering the development of products in the information domain, which encompasses many opportunities, but faces uncertainties and challenges, as well.

Instructors can use this case to discuss uncertainties and tools to mitigate risk. Readers must think strategically about innovation and the uncertainties associated with each innovation project. Beyond a listing of uncertainties, readers are also challenged to think about ways to mitigate risk through the use of real options, an options portfolio, and organizational structure.

Keywords: Deere and Company, uncertainty, real option, organizational structure, option, risk, innovation

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Introduction

The agricultural equipment division of Deere and Company was facing a number of challenges and opportunities in the spring of 2007. The fundamental challenge was to continue to improve their financial performance with an increased focus on growth without sacrificing profitability. Although improving profitability was hard to implement, the approach was well understood—lower cost, reduce assets or increase asset utilization, increase sales, and improve price realization by reducing discounts and similar price-cutting programs.

Growing the business was going to be more difficult. The U.S. farm machinery and equipment business was a relatively mature market. Clearly, there were opportunities for significant growth globally—Brazil, Argentina, the countries of the former Soviet Union, and eventually China and India provided significant potential. Furthermore, Deere had been quite successful in growing its non-traditional ag business and its consumer products segment, which focuses on products such as small tractors, lawn mowers, golf course equipment, and other consumer products and tools. However, Deere Ag Division was responsible for the growth strategy in the U.S. farm machinery and equipment business, a much tougher market to grow given that cultivated acreage was not increasing and sales were cyclical and highly dependent on farmers' incomes. But, CEO Robert Lane had not let the division off the hook. Growing the agricultural business in the United States was also important, and that required continued commitment to innovation and new product introductions. Lane challenged the team to bring new products and services to market that would meet Operating Return on Assets (OROA) and Shareholder Value Added (SVA) goals, as well as grow the division at a rate almost twice the industry growth rate of the past 20 years.

Deere was known in the farm equipment industry as an innovator with a constant stream of new products in power, tillage, planting, and harvesting equipment. Many of the most successful innovations of the past couple of decades were primarily product enhancements during a period of reduced labor use and rapid mechanization in the farming sector. The challenge going forward was how to grow the farm machinery and equipment business in a period of increasing competitive pressure, a relatively mature U.S. agricultural market, high market uncertainty (ethanol, farm bill, gas prices), high technological uncertainty (GPS), and shortened cycle time in the innovation process because of market and competitive pressures. Despite the challenges, the Ag Division management team had a number of alternatives that it could pursue, actually too many for its budget. Consequently, the team needed to develop and implement a systematic process for assessing each innovation's potential and to use that process to allocate financial and personnel resources to the highest payoff innovations that would meet corporate growth-rate goals and yet mitigate the aforementioned uncertainty.

Deere's History: A Commitment to Quality and Innovation

The legendary agribusiness Deere and Company was founded in 1837 by John Deere, a Vermont blacksmith who, a year earlier, had created an innovative design for self-scouring plows for the Midwest prairie soil. More than a century later, Deere's "leaping deer" logo is known and trusted universally in the marketplace and continues to symbolize innovative engineering and rugged construction in agriculture equipment and tractors.

Continuous innovation and new product introductions are a result of a major commitment of resources to research and development (R&D) and new product commercialization. Deere's resource commitment to R&D is summarized in Table 1; commitments to R&D have consistently been strong compared to competitors. Exhibit A summarizes some of the major innovations and new product introductions during the past 50 years. Innovations have involved improvements in tractors, combines, implements, and sprayer machinery (sustaining innovations), and more recently, in some new information and electronic-based technology, such as global positioning systems (GPS) guidance products.

Table 1. Sales and R&D Expenditures for Deere and its Competitors

$ (in million)	**Net Sales**	**R&D Expenses**	**R&D as a percent of net sales**			
	Deere	*Deere*	*Deere*	*AGCO*	*CNH*	*CAT*
2006	19,884	725.8	3.70%	2.40%	3.00%	3.50%
2005	19,401	677.3	3.50%	2.20%	2.60%	3.20%
2004	17,673	611.6	3.50%	2.00%	2.30%	3.30%
2003	13,349	577.3	4.30%	2.00%	2.60%	3.20%
2002	11,702	527.8	4.50%	2.00%	3.00%	3.50%
2001	11,077	590.1	5.30%	2.00%	3.40%	3.70%
2000	11,168	542.1	4.90%	2.00%	3.60%	3.40%

Source: Annual reports from Deere and Company, AGCO, CNH, and Caterpillar

The Lane Challenge

The 170-year history of Deere and Company is characterized by both innovation and quality. Even during the agricultural recession of the 1980s, Deere maintained its focus on delivering quality products that customers valued, and Deere gained market share as other major agricultural equipment companies stumbled or fell by the wayside. But financial performance was cyclical, and Deere typically earned a competitive return on capital for only a few years in a row before it encountered a significant downturn in performance (Table 2). When Robert Lane became CEO and chairman in 2000, his goal was "building a business as great as our products" (Nickum, 2005).

Lane's basic strategy to meet this goal was relatively straightforward—to achieve exceptional operating performance and disciplined growth and to do it through high-performance, aligned team work. Operational performance has been improving through the classic approaches of cost reductions, improved asset utilization and margin enhancing/value pricing, and metrics and reward systems that enable the organization to reach new levels. Growth was and continues to be a more difficult challenge since Deere already enjoys a strong market share position in the American and Canadian farm machinery and equipment markets, and that market has been growing only at the modest rate of 3 to 5 percent per year. Growing, therefore, required a continued commitment to innovation and new product introductions.

As noted earlier, Deere's financial commitment to innovation had been unwavering. This commitment to R&D and innovation was the key to avoiding what Lane described as "commodity hell" where tired products and services result in "me too" products that may satisfy current customer needs but do little to anticipate future needs or opportunities, thus precluding earning above-average profits.

Table 2. Deere's Financial Performance

Deere and Company			Revenues by segment				
$+ millions	*Net sales of Equipment*	*R&D*	*Ag Equipment*	*Commercial & Consumer Equipment*	*Construction & Forestry*	*Credit/Financial services*	*Total # of employees*
2006	19,884	726	10,232	3,877	5,775		46,500
2005	19,401	677	10,567	3,605	5,229		47,400
2004	17,673	612	9,717	3,742	4,214	1,276	46,500
2003	13,349	577	7,390	3,231	2,728	1,347	43,200
2002	11,702	528	6,792	2,712	2,199	1,426	43,100
2001	11,077	590	6,269	2,667	2,086	1,439	45,100
2000	11,168	542	5,934	2,966	-	1,323	43,700
1999	9,701	458	5,138	2,648	-	1,136	38,700
1998	11,925	444	7,217	2,124	-	971	37,000
1997	11,081	412	7,048	1,772	-	818	34,400
1996	9,640	370	-	-	-	-	33,900
1995	8,830	327	-	-	-	-	33,400
1994	7,663	276	-	-	-	-	34,300
1993	6,479	270	-	-	-	-	33,100

Source: Deere and Company's annual reports

But a financial commitment to innovation is unlikely to be successful without a disciplined approach to new project selection. An Accelerated Innovation Process (AIP) had been implemented at Deere to evaluate new product/service initiatives more systematically and quickly. The AIP starts by identifying areas of opportunity for innovation where it is perceived that Deere has the capacity and ability to participate. This step is followed by opportunity identification where internal capability is matched with current and future customer needs; this step requires intense and sometimes contentious discussion and dialogue between the marketing/sales staff who represent the customer's perspective and the engineering/technology personnel who focus on the capability and capacity of current and future technology. The entire process is driven by a set of financial performance metrics that maintain consistency and indicate the expected contribution of an innovation to Deere's financial performance.

An additional dimension of Deere's approach to innovation had been to broaden the focus beyond the traditional emphasis on mechanization. Much of Deere's history had been built on sustaining innovations that generally involve improving the performance and/or lowering the cost of current product/service offerings to current customers. In contrast, breakthroughs or disruptive innovations are new product/service offerings to new or underserved customers; these innovations frequently require capabilities and capacities that may be beyond the current skill set of the organization, and they may require a more intimate knowledge of potential new customers which may not be the focal point of the current sales/marketing initiatives.

One of those potential breakthroughs or disruptive areas of innovation was in the realm of information management/precision/traceability—an opportunity that is increasingly evolving because of the high demand for quality and food safety attributes across the food production and distribution value chain, and the increased capability and capacity of information technology and telemetry to automatically, in real time, measure, analyze, and deliver critical data and information to improve management decision making. As just one example, Robert Lane had described "[…] the shift to intelligent machinery. The technology is becoming available to us to bring to the customer intelligent, mobile machinery. And these machines will be doubly smart, because every day out in the field has different weather conditions and growing conditions. To send a smart machine into an environment that is changing every day it has to be intelligent enough to be adaptive (Houlihan, 2007)."

Deere was well aware of the traditional approach to thinking about growth in terms of both customers and products as reflected in Figure 1. Their perspective was that more focus needed to be placed on new products offered to old customers, as well as new customers, but these opportunities were characterized by high technical, as well as high market uncertainty. The Deere Ag Division found the current discussion about precision agriculture and traceability across the food production/distribution value chain interesting. But were its customers and other participants in the food production/distribution value chain ready to adopt these new disruptive innovations? And, was the information technology available and adaptable to the agricultural production and food distribution industry? Those were some of the questions at the top of the agricultural team's mind as it contemplated the critical decisions it had to make.

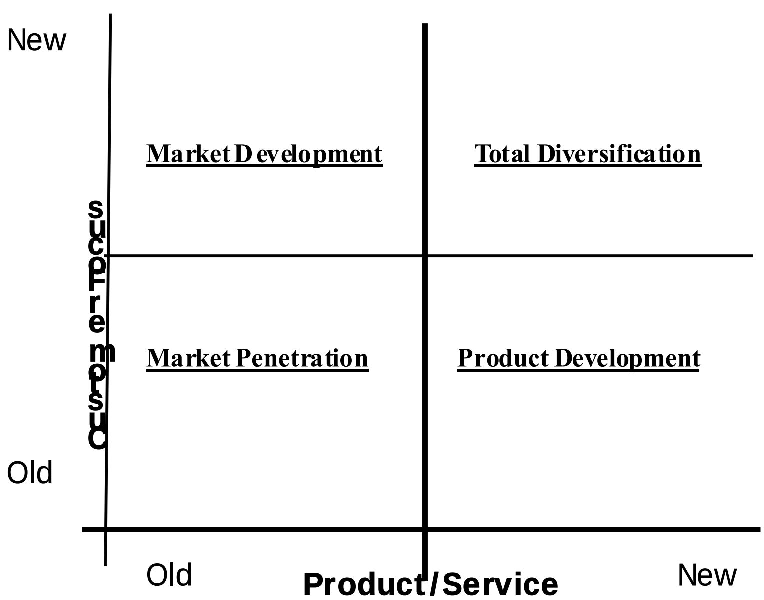

Figure 1. Ansoff's Product/Market Growth Matrix
Source: Ansoff (1957)

Although Deere had been a leader in commercializing new products and services in the farm machinery and equipment industry, it also had been focused on maintaining high-quality products that provide reliable and consistent services and experiences for its customers. So in some cases, Deere's historical approach to innovation might be best described as a "fast follower" or "close second" rather than a "first mover." A key component of Deere's commitment to quality had been the Enterprise Product Development Process (EPDP), which is a well-defined stage gate process that products must go through to assure reliable performance before a commitment to launch or commercialize is made. This process assures quality in products; however, as an integrated process, it can take more time than the marketplace may accept. The concern became then, that in the information/electronics domains, the rapid rate of technical change meant that the cycle time for successful innovation had to be accelerated and that some of the processes Deere had historically used to assess innovations maybe needed to be revamped.

Customer Segmentation

Deere had historically focused on and had a strong market position in power, implement and combine equipment with traditional commercial producers in Midwest corn/soybean agriculture. This historical dominance with this customer base had reinforced the perception that the U.S. market was mature, and growth potential was limited. But, by reassessing the market with a customer segmentation focus, a different story began to emerge.

Indeed, Deere's segmentation analysis suggested that there are eight different and important customer segments in the farm machinery and equipment market (Figure 2) with different attitudes, goals, behaviors, and needs. Deere's focus on the traditional segment, which had been historically the most important segment in the industry, had been the source of its success in the

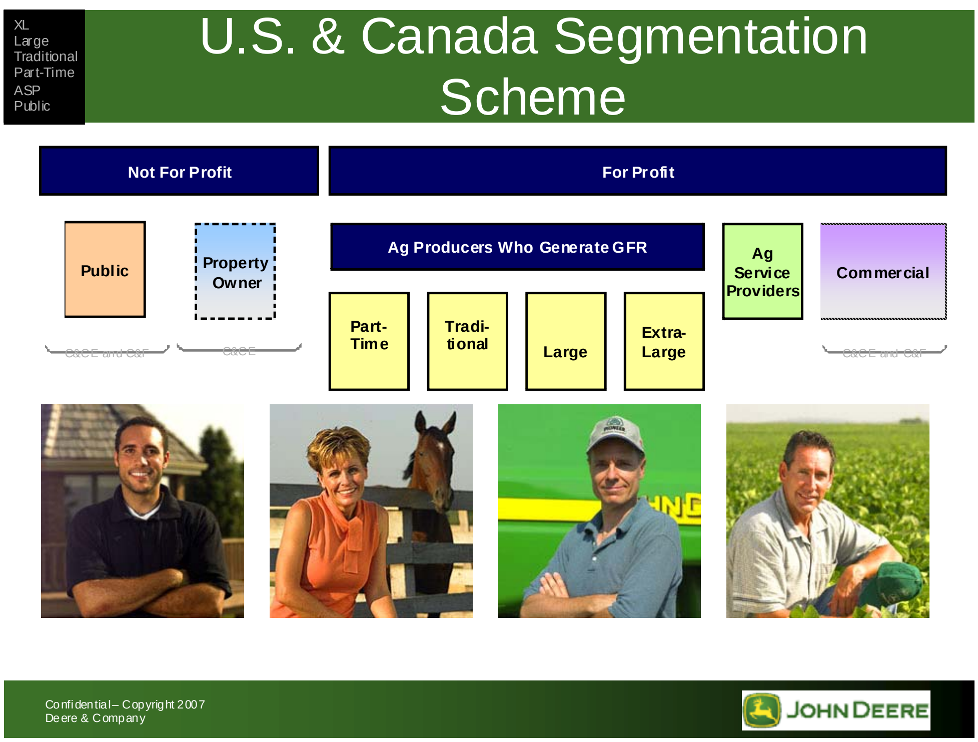

Figure 2. Deere's U.S. and Canada Segmentation Scheme
Source: Provided by Deere and Company

past. But, the industry was changing rapidly, and the other segments were becoming increasingly more important (Figure 3). Some of these new growing segments—particularly the large/mega farm, the ag service provider/custom contractor, and some of the not for profit (state and federal government, etc.)—needed machinery and equipment with different features. Larger scale growers and specialty crop producers were increasingly concerned about precision and process control systems. They were more likely willing to adopt electronic technology as long as it was simple to use and reliable.

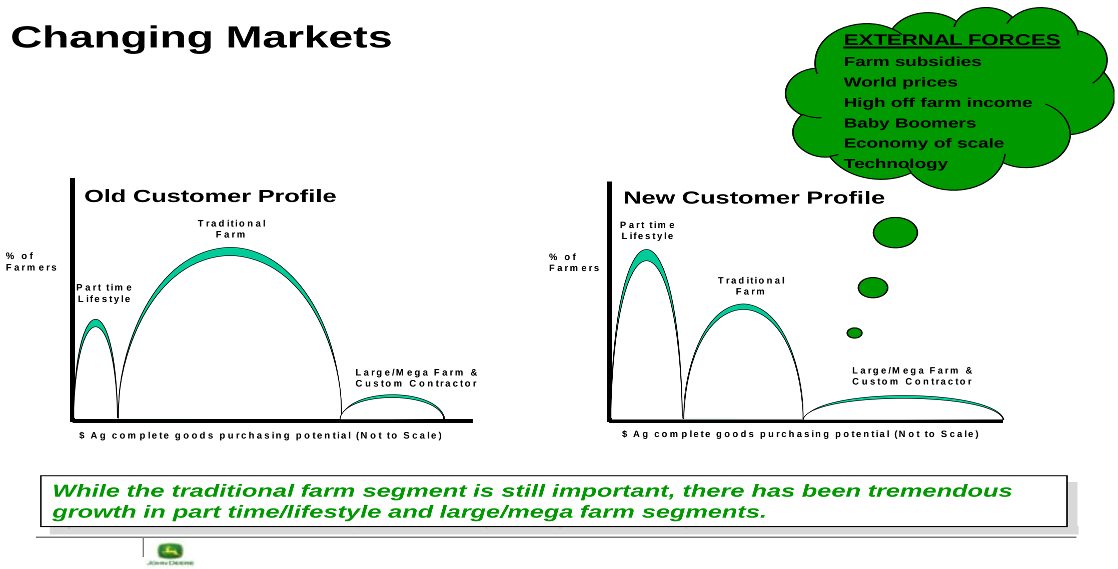

Figure 3. Evolution of Deere's Customer Segments
Source: provided by Deere and Company

These segments were currently underserved by Deere both in terms of market share and features, thus providing significant growth opportunities. Also, proving the information based technology in terms of reliability, ease of use, and value for these segments, combined with the continuous cost reductions and technological advances of electronic-based technology, would allow Deere to market these products to traditional and smaller producers in the future. Results from Deere's market segmentation work suggested that, in fact, the U.S. farm machinery and equipment industry may have substantially more growth potential than was perceived, and that new information/precision/electronic-based technology (i.e., precision farming) had the potential to be the entry point and the lynch-pin to capturing this growth potential.

The New Product/Service Choices

The Ag Division had identified five basic domains of innovations in the area of precision farming that might be offered to the market: (1) advanced autotrack/guidance/headland management, (2) variable rate seed/fertilizer/chemical application, (3) telematics, (4) information/data management along the value chain, and (5) synchronized and autonomous equipment.

Precision farming dates back to the first yield mapping system presented by the company Ag Leader in 1992, shortly after GPS technology became available to the public. Precision farming recognizes to the concept of in-field variability. It results in performing the right task, in the right place, at the right time. Most precision farming systems consist of a GPS receiver, display unit, and desktop software. John Deere's history in precision farming dates back to 1994, with the introduction of a yield-mapping system, and has evolved into five distinct categories: guidance, machine control, telematics, information management, and robotics.

Guidance—The ability to pilot farm machinery through a field via GPS satellite signals to reduce overlap and improve efficiency (by increasing speed of operation, allowing more work at night and/or in low visibility conditions, making the operator less tired).

Machine control—Systems that automate tractors, sprayers, planting, and implement functions, such as speed, hydraulic control, on/off control, and rate control to reduce inputs, decrease costs, and be more environmentally responsive.

Telematics—A wireless communication system between a vehicle and a remote site, transmitting information about the vehicle and its environment. Maintenance information can be recorded; location of the equipment can be known at all time; productivity, idle, and transportation times of the equipment can be calculated. In short, the systems can be used for efficiency and equipment management.

Information management—Collecting data about fields, including field location, seed variety planted, seeding depth or planting height, tillage depth, application depth or height, amount of products applied, crop yield, harvest moisture level, and weather conditions to make maps and informed decisions. The information can be transferred along the value chain to improve efficiency and quality control.

Synchronized and autonomous/robotic multi-unit operations—Wireless operation and control of multiple machine units (tractors, swathers, harvesters) by one operator.

The Ag Division faced several challenges in these five domains. First, customer adoption behavior had propelled the direction of precision farming solutions in several ways. The rapid adoption of guidance and machine control products was the result of customers directly reaping the benefits of increased productivity, ease of operation, and reduced input costs. Documentation and information management solutions struggled due to the inability for customers to see a direct benefit. Precision farming products overall had met complexity and price resistance adoption challenges.

Second, having products that were compatible with older John Deere equipment, as well as competitive equipment, was an eminent priority. John Deere battled enabling compatibility with their first systems and the rest of the industry. Full integration of precision farming products into John Deere equipment was challenging as a result of different product life cycles varying between precision solutions and equipment vehicles.

Third, competition was, of course, an issue. With high potential for growth in the market, many other companies tried to capture this emerging global business. Those companies included:

Trimble, Topcorn, Outback, Leica, AutoFarm, Ag Leader, and Raven, for example. Trimble and Topcorn offered guidance, application, water management, and information management systems (software for planning and documentation). Outback and Leica sold guidance/steering systems. Autofarm and Ag Leader provided guidance/steering systems, as well as data collection products. In addition, Ag Leader also marketed application control systems. Raven focused on the application control domain. Furthermore, the major ag machinery equipment manufacturers (such as CNH, AGCO, and CAT) also offered precision farming technology.

Finally, the agricultural team was concerned about dealer support. They had just begun training dealers on auto-trac products. This was a necessary, but time-consuming process. Now, they were also under pressure to develop training material for the other domains and convince dealers to spend more time away from their dealerships for training.

The Market

Farmers have adopted information technology in fits and starts. Although the use of computers and access to the Internet had expanded in recent years as reflected in Figure 4, farmers continued to lag behind other industries in the broad use of electronic technology for business decisions (in fact only about 30 percent of farmers used computers for business purposes in 2003), making the adoption of precision products a challenge. Adoption of precision farming technology has paralleled that of computer technology, but maybe with even more uncertainty. Data from the Agricultural Resource Management Survey (ARMS) shows that yield monitors and guidance systems were being adopted at a relatively rapid pace, but other technologies, such as variable rate application of fertilizer, lime, pesticides, and seed, as well as yield mapping, geo-referenced soil mapping, and remote sensing were lagging in their adoption rates (Table 3).

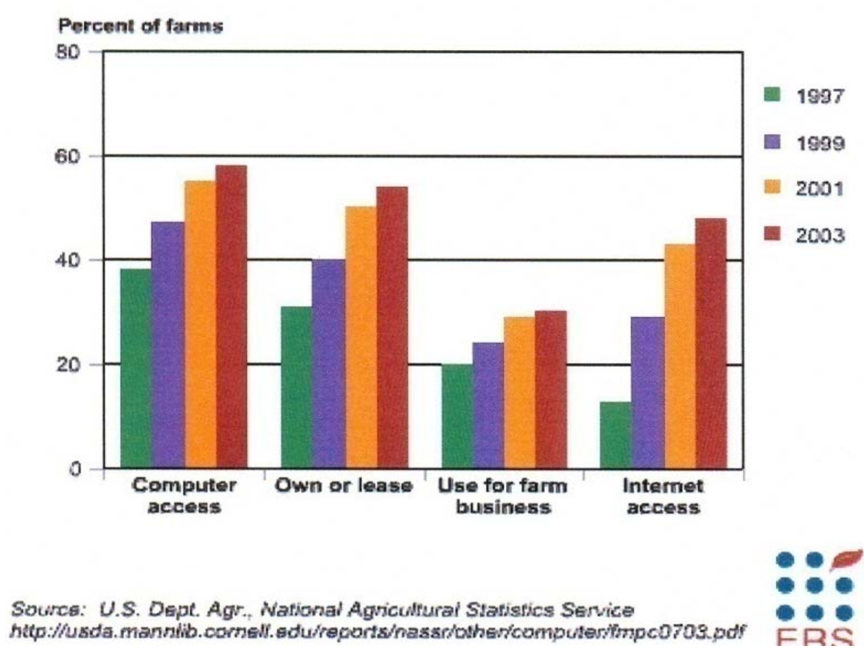

Figure 4. U.S. Farms Using Computers, 1997–2003
Source: Daberkow et al. (2006)

Economic analysis of the benefits to precision farming techniques indicated that guidance systems had the fastest payback, and variable application of lime also had financial benefits, but other precision farming technologies and techniques were not yet seen as highly profitable. Academic studies and budgeting analyses of various precision farming practices underscore the uncertainty of the economic and financial payoff to producers adopting some of these practices. Analyses of the investments in auto guidance technology indicate a 20 percent increase in field speed (Watson and Lowenberg-DeBoer, 2002). Yield monitoring technology does document variability in yields in different fields with different soil types, but explicit links to differences in fertility and other management practices to enhance yields is less clear (Lowenberg-DeBoer and Aghib, 1999; Peone and Lowenberg-DeBoer, 2004). Site specific and variable rate applications of lime would appear to have significant economic benefits, but precision applications of seed and fertilizer do not have the same potential at prevailing product prices and fertilizer and chemical costs (Bullock et al., 1998; Doerge, 2002).

Table 3. Share of U.S. Acreage Using Precision Agriculture Technology[1]

Technology	**Sunflower 1999**	**Potatoes 1999**	**Sugarbeets 2000**	**Rice 2000**	**Barley 2003[2 3]**	**Sorghum 2003[2 3]**
Yield monitor	17.1	10.4	1.0	17.6	17.0	14.4
Yield map	3.8	10.2	*	5.1	4.6	2.0
Geo-referenced soil map	3.8	18.7	28.6	9.5	7.3	7.3
Remote sensing	4.4	20.5	35.2	4.7	2.8	4.4
VRT used for:						
Fertilizer/lime	2.8	13.1	11.9	1.6	12.9	4.7
Seed	*	1.5	2.2	1.2	8.0	3.5
Pesticides	*	3.6	1.3	2.6	10.4	2.7
Guidance	NA	NA	NA	NA	14.7	10.4

*= less than 1 percent. NA = survey not conducted. VRT = variable-rate technology
[1]These estimates are revised from previous published estimates based on updated weights from the ARMS.
[2]Prior to 2002, respondents were asked if the soil characteristics of the field had ever been geo-referenced. Beginning in 2002, respondents were asked about geo-referencing in the current and previous years.
[3]The question was reworded in 2002 to better define the term "remotely sensed.*
Source: Daberkow et al. (2006)

A survey of retail agronomy dealerships concerning precision agriculture services indicated similar uncertainty in adoption. While more than 80 percent of the 340 respondents used some form of precision technologies in their dealerships, the applications were primarily dominated by service offerings to customers and manual control/light bar GPS guidance of application equipment (Figure 5). Specific service offerings over time have grown erratically since the mid-1990s and still did not exceed 50 percent of the respondents as of 2006 (Figure 6). Midwest dealers were significantly more likely to offer most precision services compared to other regions of the United States (Figure 7).

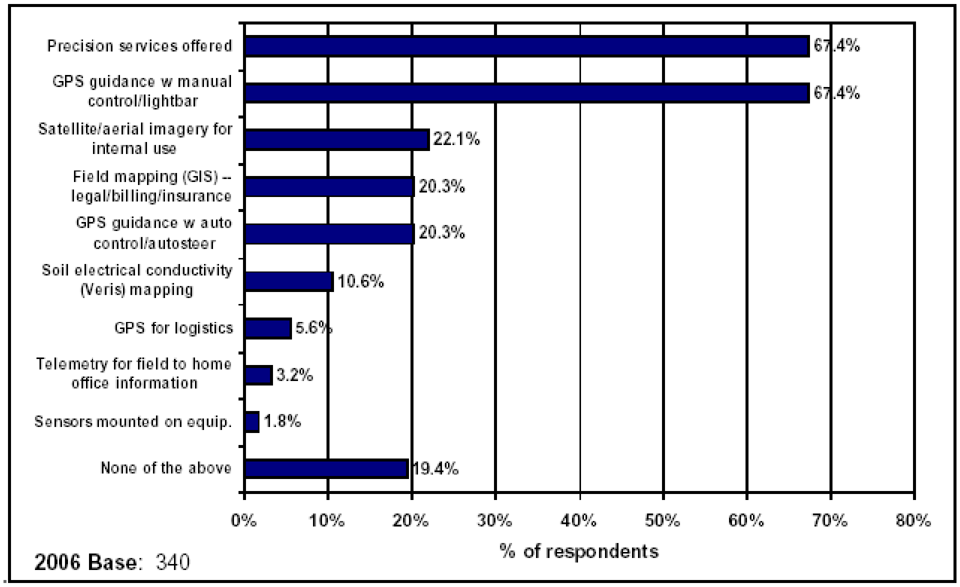

Figure 5. Use of Precision Technology in 2006
Source: Whipker and Akridge (2006)

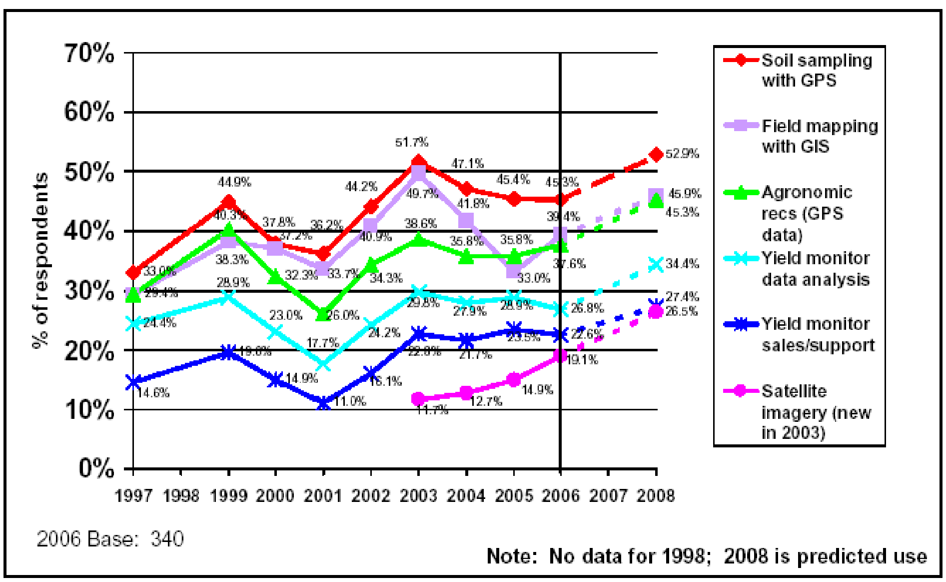

Figure 6. Precision Ag Services Offered Over Time
Source: Whipker and Akridge (2006)

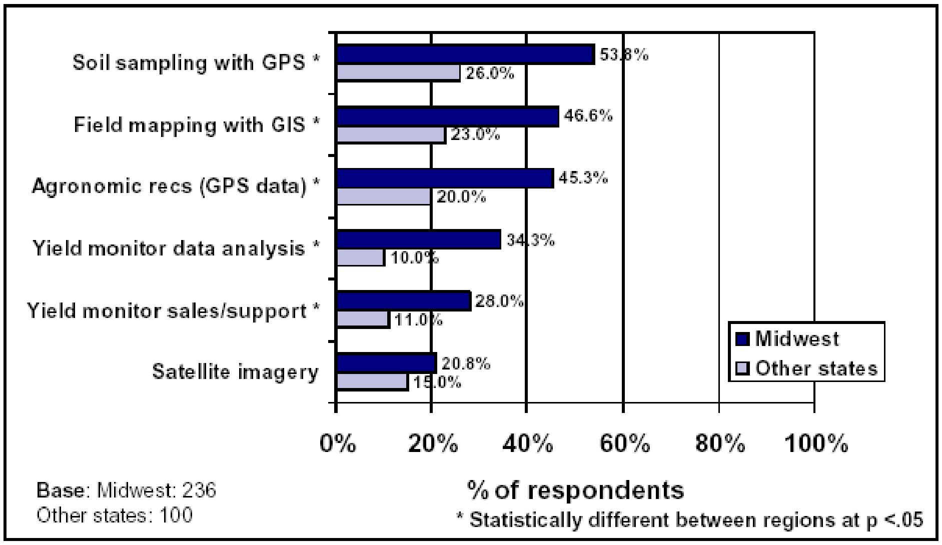

Figure 7. Precision Ag Services Offered by Region in 2006
Source: Whipker and Akridge (2006)

Data from surveys of Ohio farmers in 1999 and 2003 suggested that adoption of precision farming practices was progressing at a slow to moderate pace. As summarized in Table 4, the most frequently adopted precision farming practice was geo-referenced grid soil sampling—adoption increased from eight percent of the respondents in 1999 to 15 percent in 2003. Variable rate application of plant nutrients showed similar rates of adoption and growth in adoption since 1999. Yield monitor adoption nearly doubled from 6 percent to almost 12 percent from 1999 to 2003; precision guidance was not generally commercially available in 1999 and had been adopted by 5 percent of the survey respondents by 2003. Approximately one-third of the surveyed farmers had adopted one or more of the precision farming practices in 2003, compared to less than 25 percent in 1999. As expected, larger farmers adopted precision farming techniques more rapidly and were using a larger number of such techniques compared to smaller farmers.

From a global perspective, the data is only available on yield monitor use and indicated that the United States and Germany appear to have the highest use, with lower utilization in Denmark, Sweden, and Argentina (Table 5). Success in expanding their footprint in precision farming technology in the United States would allow Deere to better understand customers' needs, which could then possibly be leveraged in other countries.

Table 4. Percent of Ohio Farmers who had Adopted Various Precision Farming Components in March 1999 and 2003

	Percent Adopting	
	2003	1999
Georeferenced (i.e., map-based or location specific) grid soil sampling	15.3	8.1
Variable Rate Application of Phosphorus	14.1	7.3
Variable Rate (i.e., rate varied across field) Application of Lime	14.0	6.7
Variable Rate Application of Potassium	13.4	7.3
Yield Monitor	11.6	6.0
Boundary Mapping	9.8	4.3
Variable Rate Application of Nitrogen	7.7	6.3
Satellite GPS Receiver	7.6	2.2
Georeferenced Field Scouting for Weeds	6.0	2.3
Variable Rate Application of Herbicides	5.3	5.7
Precision Guidance (light-bar navigation or autopilot system	5.2	
Aerial or Satellite Field Photography	5.2	2.7
Georeferenced Field Scouting for Insects, Pests, or Disease	4.9	2.0
Variable Rate Seeding	4.2	3.4
Variable Rate Application of Other Nutrients	4.1	3.9
GPS or Sensor-Directed Spot Spraying of Herbicides	3.0	1.3
Variable Rate Application of Pesticides	2.8	2.9
GPS or Sensor-Directed Spot Spraying of Pesticides	0.9	
Percent who have adopted one or more of above	31.8	23.6

Source: Batte et al. (2003)

Table 5. Yield Monitor Use by Country

Estimated			Yield Monitors	
Country	Number	Year	Source	per 1,000,000 acres
Americas				
United States	30,000	2000	Daberkow et al.	136
Argentina	560	2002	Bragachini	10
Brazil	100	2002	Molin	1
Chile	12	2000	Bragachini	8
Uruguay	4	2000	Bragachini	3
Europe				
U.K.	400	2000	Stafford	43
Denmark	400	2000	Stafford	100
Germany	150	2000	Stafford	7
Sweden	150	2000	Stafford	48
France	50	2000	Stafford	2
Netherlands	6	2000	Stafford	11
Belgium	6	2000	Stafford	6
Spain	5	2002	4ECPA	<1
Portugal	4	2002	Conceicao	3
Other				
Australia	800	2000	Bullock et al.	17
South Africa	15	2000	Nell	1

Source: Lowenberg-DeBoer (2003)

The Key Questions

The challenge was clear. How might the Ag Division deliver on this challenge? Although there were numerous opportunities for new product and service introductions in the traditional areas of enhancing the performance and productivity of Deere's power, tillage, and harvesting equipment, the Ag Division felt that the most potential, but also the most uncertainty, might be in the five new domains of precision farming. Some of the top-line questions the Ag Division management team had decided to focus on were:

1. What are the types/dimensions of risk/uncertainties associated with innovations in the information domain? Give specific examples in each dimension related to Deere and the information domain.

2. What kinds of customers (in terms of age, size, crops produced, etc.) provide the most potential for adopting the products/services in these domains?

3. What are the capacities needed to develop, produce, and commercialize information domain products? Does Deere have the capabilities? If not, how should Deere go about getting the capabilities?

4. How can Deere manage the risk/uncertainties associated with investing in the information domain? Think about flexibility and the concept of real options, and suggest a framework(s) to use this concept.

5. Should Deere collaborate with specialty electronics companies such as Raven, Ag Leader, etc.? Which characteristics should Deere look for in the collaborators/partners involved in the development of new technology in these domains, and what organizational structure might be used to benefit both Deere and the collaborators?

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Appendix 1.

Exhibit A. Innovation Chronology

1957: Six-row planters and cultivators, John Deere innovations, reach the market. They provide 50 percent more planting and cultivating capacity for row-crop farmers in corn- and cotton-producing areas.

1958: The John Deere Credit Company, financier of domestic purchases of John Deere equipment, begins operations.

1963: John Deere surpasses IH to become the world's largest producer and seller of farm and industrial tractors and equipment. The company ventures into the consumer market, deciding to produce and sell lawn and garden tractors, in addition to some attachments, such as mowers and snow blowers.

1991: Lawn-and-grounds-care equipment operations in the United States and Canada become a separate division. Since 1970 they had been part of the farm-equipment operations. The company acquires SABO, a European lawn mower manufacturer.

1992: A program is launched to encourage installation of rollover protective structures and seat belts on older tractors. In 1966, John Deere introduced the first commercially available rollover protective devices for farm tractors, later releasing the patent to the industry without charge.

2001: Two mapping softwares—JDmap and JDmap Deluxe—are introduced.
Development of parallel tracking to reduce overlap.

Creation of a new service CropTracer that provides the necessary components of a full service traceability program. Launch of Field Doc, an electronic notebook that makes collecting and recording information about operations exceptionally easy.

Introduction of the GreenStar™ AutoTrac assisted steering system to reduce the amount of time an operator needs to spend steering the tractor.

2002: Development of JD Office, an extended version of JD map. Creation of a new JDLink Machine Messenger, a wireless communication and information system for John Deere agricultural tractors that makes automated fleet management a reality.

2003: John Deere Introduces GreenStar™ AutoTrac Assisted-Steering for wheeled tractors. Introduction of several product enhancements for Parallel Tracking (a manual guidance system) and expansion of the GreenStar™ AutoTrac Assisted Steering line-up with the introduction of Auto-Trac for 8020 series tractors with MFWD or ILS.

Development of JDLink™ Machine Messenger, a wireless communications system for the new John Deere twenty series tractors, which allows owners to monitor tractor performance and usage from a secure Internet Web site.

2004: Further advances in new products include recently introduced self-propelled sprayers; the 4720 and 4920 models are the Deere's largest and most-productive sprayers ever. Expansion of the GreenStar™ AutoTrac Assisted Steering System on more vehicles.

Development of StarFire RTK system with the repeatable guidance that only Real-Time Kinematic (RTK) GPS systems can deliver.

2005: Major new-product introduction for model-year 2006 with John Deere 8530 tractor; the most powerful row crop tractor ever (275-hp) that allows operators to get more done in less time. Equipped with new 9.0-liter engine, this tractor is more fuel-efficient than the previous model. Advanced precision-guidance product, which can direct equipment in the field with sub-inch accuracy, is introduced.

2006: Deere introduces a high-capacity 4930 self-propelled sprayer; the 120-foot boom makes it the most productive sprayer ever built by John Deere. Innovations such as iGuide, for perfectly straight rows; iTEC Pro for automated end of row turns, and GS2 Rate Controller to expand the capabilities of the GS2 system by acting as a controller for sprayers; reach the market.

John Deere 8430 tractor, powered by the company's clean-burning engine technology, sets fuel-efficiency record for its size class. Advanced products appear in the 6030 premium series and 7030 full-frame tractors.

A new line of productive round balers is launched.

Source: Deere and Company's Web site, Deere and Company's annual report, and "The John Deere Way: Performance that Endures" by David Magee (2005).

Appendix 2.

Addendum to the Case Study

The case study was used at an executive management education program focusing on innovation in April 2009. The executive program was a four-day session for executives from Syngenta. Prior to the case study presentation and discussion, presentations and discussions focused on how Syngenta innovates, how to create a culture of innovation, how to implement innovation, and how to communicate to customers the innovation taking place.

Case Setup

To prepare program participants for the case study discussion, a succinct presentation was given. The customer segmentation of Christensen and Raynor (2003) was introduced: over-served customers, under-served customers, satisfied customers, and non customers. Then, based on Christensen (1997), the definitions of disruptive and sustaining innovations were presented.

Sustaining innovation refers to improving a current product, while disruptive innovation refers to the creation of a new product, business model, or service.

The framework developed by McGrath and MacMillan (2000) was also presented. This framework (Figure 8) graphs the innovation projects along the dimensions of market and technical uncertainty to determine whether risk is being diversified and how the portfolio of innovations evolves over time. Market and technical uncertainties are scored using the scorecards developed by McGrath and MacMillan (2000).

Major sources of uncertainty are the potential revenue/demand, regulatory aspects, associated cost, and upstream supply chain reaction to the innovation project. Market uncertainty refers to the lack of knowledge at the market and demand level. Technical uncertainty comes from the lack of information about the viability of the innovation. The firm does not know whether or not the technology can be developed, and which inputs and skills are needed. The firm also does not know how, or if, the user will be able to adopt the product.

Figure 8 maps the variety in the chosen innovation activities. Innovation through positioning options creates the right to wait and observe. Innovation through stepping stones options gives low-risk access to potentially high upside opportunities. Innovation through scouting options can be seen as entrepreneurial experiments. Innovation through enhancement launches represents improvement to make today's product faster, better, or cheaper. Finally, innovation through platform launches consists of establishing the company in a leading position, ideally in an emerging area with strong growth potential—next generation advantages. The participants were given an illustration of the framework with Deere's example of innovation projects, excluding the information domain (Figure 8).

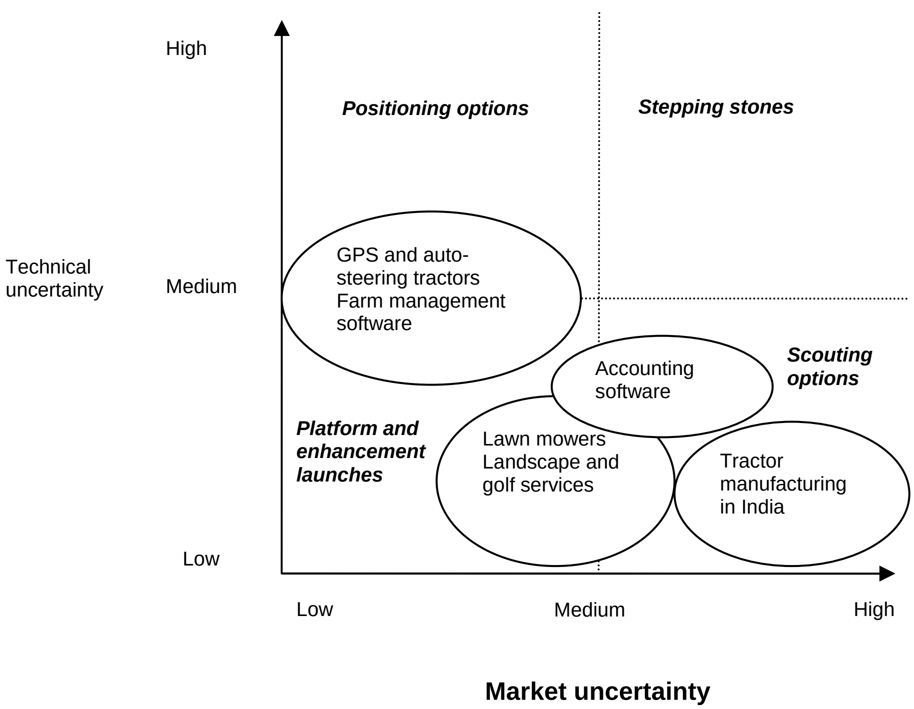

Figure 8. Portfolio of Options to Innovate

Participants' Discussion

The participants were then asked to break up into groups of four to five people and answer questions 2, 3, and 5. The other questions were not investigated because the participants had already discussed the implementation of innovation and the customer aspect of innovation at length. After the break-out session, participants presented their answers, which are described below.

McGrath and MacMillan's framework was proposed to determine the appropriate portfolio of innovation projects to fund and to manage this portfolio over time (see Figure 9). Advanced autotrack/guidance/headland management and variable rate seed/fertilizer/chemical application can be considered platform launches for Deere. They have medium technical uncertainty, but low to medium market uncertainty as the values of those technologies are fairly easy to communicate to the customers. Telematics and information management are examples of scouting options for Deere. They use developed technologies (we have telematics in our cars, planes, and trains), which limits the technical uncertainty. However, the market uncertainty is high. Sales representatives may find it more difficult to convince farmers of the benefits that these technologies bring than for products such as autotrack. Alternatively, these products may service a smaller number of farmers than autotrack systems in the short term. Synchronized and autonomous/robotic multi-unit operations are stepping stones for Deere. Requiring the use of new technologies, these products have high technical uncertainty. For the same reasons as telematics and information management products, synchronized and autonomous/robotic multi-unit operations also face high market uncertainty.

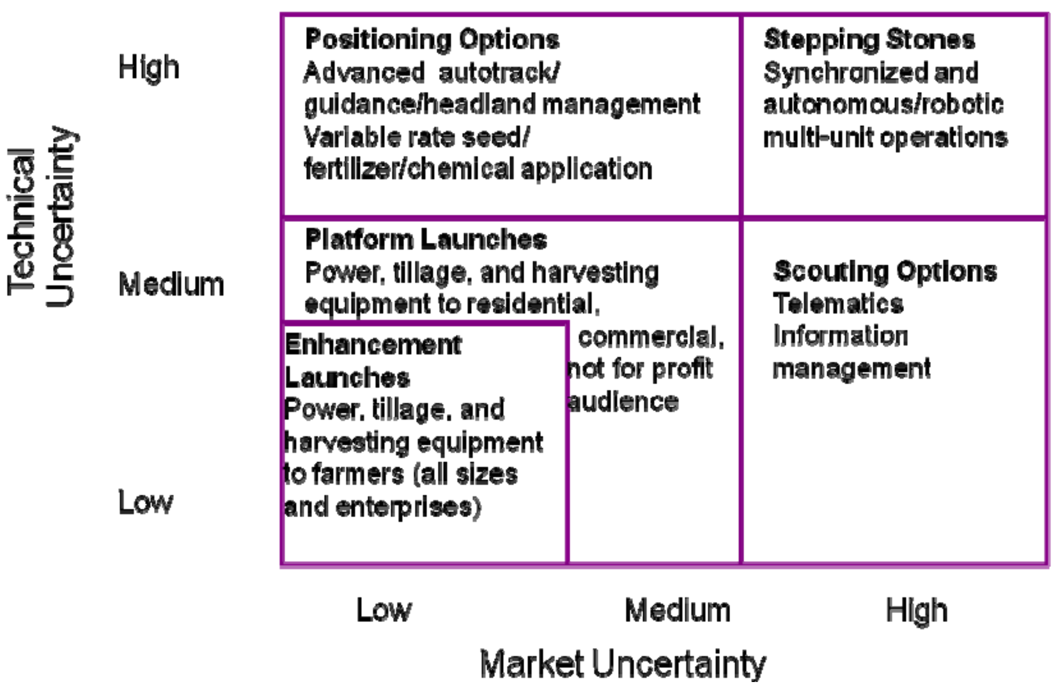

Figure 9. McGrath and MacMillan's Framework

One of the participants mentioned that the McGrath and MacMillan's framework did not take into account the market attractiveness. The instructor mentioned how the size of the circles as illustrated in Figure 8 could be adapted to represent the market attractiveness; the bigger the circle, the more attractive (in terms of generated revenue) the market.

Regarding the question on whether Deere should collaborate/partner with a specialty electronic company, most participants recommended collaboration and presented the reasons to justify this recommendation as summarized in Table 6.

Table 6. Factors Affecting the Choice of Governance Structure

Partner Don't	Partner
Access technologies	Oblige customers to use the whole Deere package
Access new customers	Nobody was better
Successful with past partnership experience	Expected payoffs
Differentiation	Culture
To mitigate risk	Provide the right quality
Flexibility to experiment with the idea and then buy the partner if it's successful	Avoid lawsuits on intellectual property rights
Speed to market	
Access to capabilities	
Share costs	
Secure channels	
Competitive advantage	

Deere's core business up until now has been machinery. For the company to enter the information domain, Deere will need to develop competencies in electronics, computer, and information technology by either buying electronic companies or collaborating with them. These electronic competencies will have to be developed throughout the supply chain. The research and development teams will have to learn about electronics, in addition to continuing their understanding of machinery. The manufacturing processes will have to be adapted to produce electronics. Deere will need to find and build relationships with suppliers of electronics. Quality controllers will have to learn about electronics. Deere's marketers and sales representative will have to learn about electronic features to market the product properly and to its fullest. Deere's dealers also have service teams at the dealership and on-site; those teams will need to have electronic experts on staff.

Participants also stressed the need for Deere to educate dealers on selling precision farming products. Both the dealers and the service teams will need to be motivated and rewarded for their effort in learning about and selling new products. They will need to understand the reasons behind the introduction of those new products or, in other words, be told about Lane's challenge. To make sure dealers devote time to selling information domain products, a dedicated salesforce could be put together. Dealers could also be encouraged and rewarded for trying to sell the information domain products as an add-on to equipment already in the field.

As a follow-up to the discussion, Dave Ehlis, director of advanced marketing at Deere and Company, provided insights regarding the discussion that had previously taken place. He noted that Deere had been prototyping and producing its precision farming products in-house with the help of selected universities and the acquisition of companies, such as NavCom technologies, to gain capabilities in navigation technologies.

There are several reasons behind these decisions. First, Deere and Company has extensive knowledge and a competitive advantage in complex machinery/product design and manufacturing suggesting a fairly hierarchical governance structure. Deere is also well known for high-quality products. This competitive advantage is best obtained with extensive monitoring (i.e., a hierarchical governance structure). Second, Deere has historically focused on and has substantial experience in producing in-house, at least partially because of the challenges in negotiating the property rights associated with a less hierarchical governance structure. Third, these products were expected to generate high profits, and Deere wanted to reach the maximum profit. Finally, those products were expected to reach current Deere customers, so the market uncertainty was fairly low, and Deere dealers could provide more of a one-stop shopping location to the farmer. The acquisition and the collaboration with universities were useful strategies to gain capabilities Deere did not have. Finally, at the commercialization level, Deere has had experience working with its dealer network, thus relying on the dealers' human capital to attract and retain customers.

Ehlis followed his case discussion with a presentation on Deere's innovation projects— its past innovations and current innovation strategy. He noted the presence of an advisory council made of diversified members from an education, culture, and experience standpoint. He also discussed and showed a video, which had been shown to all Deere employees, presenting the six dimensions/issues in which Deere is looking for innovative solutions: 1) machine productivity, 2) worksite solutions, 3) environmental sustainability, 4) renewable energy, 5) connecting land and lifestyle, and 6) water management. Ehlis ended the presentations with a question and answer session.

