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DISRUPTIVE INNOVATION IN AGRIBUSINESS

By

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Undergraduate Thesis
presented in partial fulfillment of the requirements
for the University Scholar distinction

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Disruptive Innovation in Agribusiness

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Abstract:

The purpose of this thesis is to analyze how the process of disruptive innovation will impact the agribusiness industry, and how this transition will take place. This analysis will be demonstrated through scenario analysis, with three potential scenarios being demonstrated and explained. This project was developed using research from a broad range of sources over the course of several years, as well as studies conducted within the industry itself through firsthand experience gained while working for one of the largest firms operating in this industry. While disruptive innovation has been a phenomenon studied in several industries and areas, it has not yet been applied to agribusiness. This approach looks at this well-documented process, but analyzes it from the standpoint of the agribusiness, an area that has yet to be examined. This is significant because agribusiness affects every person on the planet. From the subsistence farmer in Africa to the large scale commercial farmer in the American Midwest, to consumers around the world, nearly the entire human population relies on the agribusiness industry to manage, transport, and process simple crops into foods, ingredients, chemicals and products that nourish our bodies and build our world. Any changes that occur in this industry will theoretically spread to impact every person who consumes food with even the slightest processing, and every industry that is in any way connected to the crops and other raw materials produced by agriculture.

Introduction:

“Every once in a while, a revolutionary product comes along that changes everything.”

- Steve Jobs, Apple Inc. (*Steve*, 1)

When Steve Jobs took the stage in early 2007, the world had come to expect great things. In less than a decade, Mr. Jobs had regained control of the struggling personal computer manufacturer, refocused it, and made it profitable. He had released amazing new products that changed the way users interacted not only with their computers, but also with their music, through the highly successful iPod and iTunes Music Store. But on that day, only Steve Jobs could begin to foresee the impact his next words would have.

Smartphones had existed for many years, but were expensive, complicated, and poorly designed. They were well out of the grasp of most consumers, and their impact was limited. When Apple released the iPhone, everything changed. Suddenly, ordinary users would have access to the entirety of the internet where ever they went, and could access a seemingly limitless world of content. (Apple, 1) Though not even Apple knew it at the time, that day would propel the world into the always connected, app based world of cloud computing, and would change the world forever.

And while it is unlikely that Steve Jobs could have predicted the specifics, like the rise of the “app economy” or the incredible cultural changes that would occur from the iPhone, he knew that the iPhone was going to change everything.

The iPhone has become one of the landmark cases in a force that has been titled “disruptive innovation”, where a radical and new process or product completely upturns an entire market or industry. Disruptive innovation is by no means a new phenomenon. It has played a part in the business world for centuries. In 1997 Dr. Clayton M. Christensen of the Harvard Business School authored *The Innovator’s Dilemma*, which brought the many elements of disruptive innovation and the historical context

surrounding it into one cohesive form, and showed the world just what an important and far reaching impact disruptive innovation can have on any industry.

As the world population has grown to over seven billion people, the world of agriculture and agribusiness has become central to the ability of all people to survive and thrive. Ever since the time of Thomas Malthus and his grim outlook on a future encumbered by staggering and uncontrolled populations, mankind has concerned itself with the careful monitoring and development of a robust food supply. Small family farms have given way to large scale agriculture, and local markets to global food management markets and exchanges powered by immense agribusiness firms. While consumers may feel that they cannot live without a modern smartphone, the fact stands that they would find themselves in a significantly worse situation if something were to happen to the agribusiness industry, which has worked to prevent Malthus' pessimistic prospect from taking hold, let alone being a concern for most people living in the modern industrialized world.

In the past few years, disruptive innovation has played a pivotal role in many industries, and is spreading. What started as the revolution in personal computers, has moved into mobile computers, personal media players, the music and film industries, telecommunications, photography, commerce, publishing, business computing, entertainment, and many other industries, all of which seemed nearly completely independent of each other less than a decade ago. The message has become clear; no industry is safe. As technology continues to evolve and advance, all areas will feel the incredible force of disruptive innovation. Just as in each historical example of this force in action, there have been and will be dominant and powerful firms, unable to adapt, who fall, and agile and defiant startups to take their place. In business, just as in the natural world, this is the natural evolutionary process, but disruptive innovation is like a meteor strike, quickly upending the status quo and forcing change.

Steve Jobs stated it best. Every once in a while, a revolution comes along and changes everything.

Part 1: Overview of Disruptive Innovation through the Innovator's Dilemma

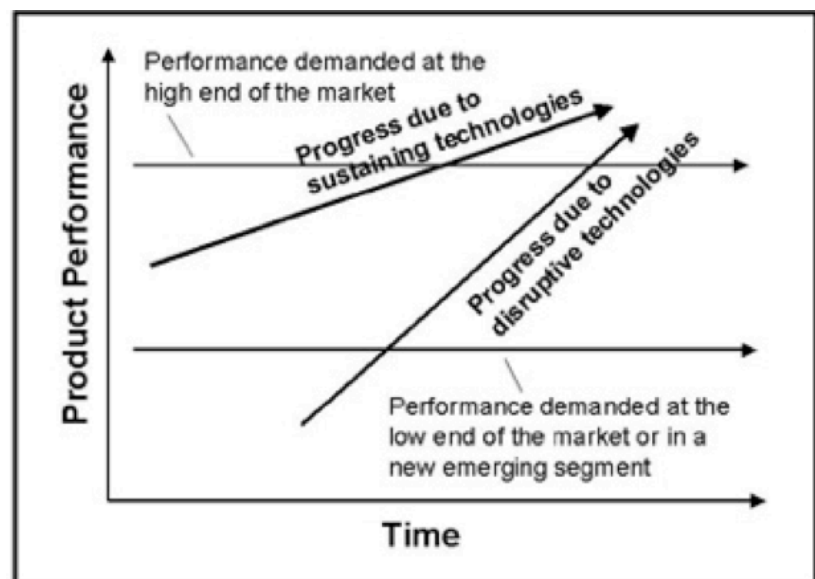
Generally, business and science are not thought to have a lot in common. One is dedicated to the advancement of human knowledge through experimentation and observation, while the other is focused on increasing shareholder value. There are, however, key areas where the two overlap, and it is possible that the two fields actually are more interconnected than is often assumed. For example, science requires the use of the scientific method, a careful process that allows scientists to craft a hypothesis, test it for accuracy, and observe results to form conclusions. In business, managers must devise a strategy, test it in the marketplace, and use the results, in the form of profit or loss, to evaluate it. Another crossover is in the area of evolution. Science has demonstrated that, through the process of evolution and natural selection, organisms gradually improve and develop in complexity to be more competitive. The same holds true in business, with what is called sustaining innovation, where products and services are gradually refined and improved over time. Science has also shown that every so often, a sudden shift or dramatic event, like a meteor strike or an ice age, can drastically change the course of the evolutionary process. Disruptive innovation acts like that meteor strike, quickly upsetting the existing market and dramatically changing the course of entire industries.

Linking back to the example in the introduction, each year, Apple Inc. would introduce a newer version of its iPod media player, generally with slight improvements like a bigger storage capacity, a better screen, or a new feature like the ability to play videos. These innovations were sustaining in nature, slowly improving upon the original and protecting the product's strong competitive edge as others tried to mimic it. But in 2007, Apple did something completely unexpected, it released a mobile phone that offered a completely new experience and was an order of magnitude better than the existing offerings in the market. The iPhone is a classic example of disruptive innovation, where a new product is introduced and changes the entire market.

In 1997, Harvard Business School professor Clayton Christensen wrote what would become the handbook for disruptive innovation, *The Innovator's Dilemma*. (Christensen, xi-xxxii) This book offers a detailed outline of what disruptive innovation is and how it occurs, and offers guidance to companies facing this situation. His text examines why great companies fail, and how disruptive innovation has a tendency to be incredibly hard to foresee, yet to be obvious in hindsight.

Disruptive innovation, Christensen argues, occurs when companies become too locked into their current products and into providing sustaining innovations, and become unable to take the risks or see the future potential benefits in new technologies. Christensen created a graph to show why this occurs, noting how when a disruptive innovation is first introduced, it often falls well below the capabilities of the existing technology. However, the key factor that makes a disruptive innovation so powerful is its ability to rapidly improve, much faster than the existing product, and eventually surpass its capabilities. Managers typically only see disruptive innovations as more expensive alternatives with less compelling capabilities, and are hesitant to invest in their development. This inability to understand and anticipate the rapid development of a new technology is typically what eventually causes market leaders to fail.

In his book, *Does IT Matter?*, author Nicholas Carr expands upon Clayton Christensen's concept of disruptive innovation and provides a powerful historical example that demonstrates how this force plays out in an industrial setting. While his book contains several great examples, the example of electrification of mills closely



(Disruptive, 1)

relates to this industry and clearly shows how disruptive innovation affects firms in three distinct ways.

As the industrial revolution shifted Europe and eventually the world away from individual and inefficient small scale production toward centralized factories where goods could be manufactured on an incredible scale with great efficiency, it led to many developments to allow these factories to operate on such a large scale. One such technology was a method of power distribution, where steam or water power turned a single drive that was connected to a series of belts and overhead rods to distribute the power throughout the factory to the many stations. While this development was a great leap forward, it was not without drawbacks, such as the inability to shut down a single work station for repairs without disrupting the power supply for the entire factory, and an inevitable cut in mechanical efficiency due to friction caused by the various belts and pulleys used to transfer mechanical power throughout the plant.

One textile mill, the Ponemah mill in Connecticut attempted to transition to new and more efficient electricity for its power source and replaced its steam and water based inputs with a single electric motor connected to a hydroelectric dam. While it did see benefits from this move, it was not able to realize the true capabilities of electricity, its ease of distribution within a plant, and saw the same disadvantages that had plagued its operations with the overhead belt drive system. (Carr, 21)

Others, like the Columbia Cotton Mills, understood that there were far greater advantages if electricity was used to its full potential, and replaced not just the main input, but rather the machines themselves, and used an electric motor at each individual work station that connected into an electric grid. These new machines were smaller and more efficient, allowing the plant to add 20-30% more capacity within the same square footage of factory floor. (Carr, 22)

Other firms simply did not see any advantage to electric drive, or did not understand the new innovation and refused to modernize. They quickly found themselves unable to

compete with those who had updated and were more efficient and productive, and were pushed out of the market. A core trademark of disruptive companies is their ability to “create innovations that invade the market, force change, and create new sectors of the industry” and in this example, the companies who were able to do this were the ones that ultimately found success and survival. (White, 1)

Lastly, the companies who benefitted the most were new entrants, who had “grown up” with concepts of electrically driven systems that powered individual work stations. These companies were not burdened by an existing legacy focused around the now obsolete overhead belt drive technology and were able to be even more efficient than the firms who had transitioned.

Now, another disruptive innovation is taking hold and spreading throughout the business world. Just as the industrial revolution and later electrification radically changed the business landscape, the area of information systems is quickly demonstrating a capability for incredible gains for the firms who accept and utilize it, and a destructive power for those who ignore and reject it. While this paper does not focus on what the disruptive innovation facing this industry is, but rather how its arrival will impact the field of agribusiness, information systems is one of the most likely candidates for what the disruptive force will stem from.

Luckily, agriculture and agribusiness has already seen a disruptive innovation and has felt its impact. While this example has not been as directly applied to the model of disruptive innovation as those found in Christensen’s and Carr’s models, the development of mechanized agriculture was undoubtedly a disruptive innovation that had an incredible impact not only on the agricultural industries, but on our entire society, by radically increasing the efficiency of a single farmer and allowing a much larger percentage of the population to work in industries that are not tied to food production. (Wells, 375) (Moore, 17)

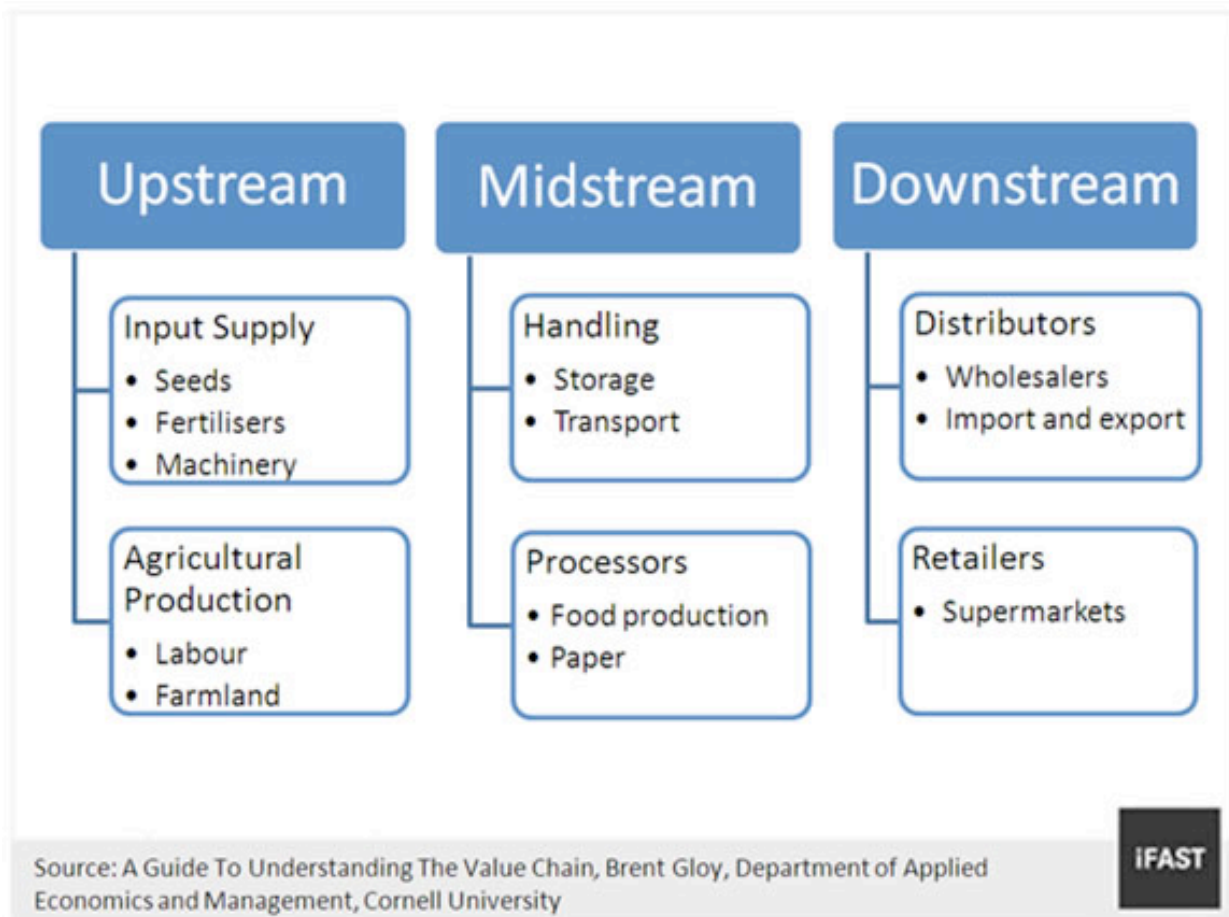
Part 2: Overview of Agribusiness Industry

To understand why examination of disruptive innovation occurring within the agribusiness industry would be so critical, it is necessary to understand why the agribusiness industry itself is so important. The agribusiness industry touches nearly every single person living on the planet, which is something that very few areas of business can claim. (Agribusiness, 1)

Every living person must eat nearly every day to survive, this is a fact of life, and for most of human history, this task was accomplished by each individual sourcing, gathering, and preparing enough food to sustain themselves and those who depend on them. While very simple, this system is incredibly inefficient and limited the development of human society, because there was no capability for individuals to specialize and perform tasks that did not involve hunting and gathering food for themselves. Eventually, humans learned how to produce food (basic small scale farming), rather than merely finding it (hunting and gathering), and with time became more and more proficient at it, allowing an ever expanding section of the population to work in other areas that benefitted all of society. With the rise of the industrial revolution, mechanization was added to the equation, necessitating an even smaller percentage of the total population to produce enough food to feed everyone. Agribusiness, just as the factories in Nicholas Carr's examples, was profoundly impacted by the disruptive innovations of the industrial revolution, and saw previously unimaginable gains in efficiency and productivity.

As modern agriculture developed, it required fewer and fewer people directly working the land, but a larger industry of supporting activities and processes. Today, the agribusiness industry is defined as all business and industries that are involved in production of food. This includes farming, but also seed production and distribution, chemicals (pesticides, herbicides, fertilizers, etc.), machinery, processing, and merchandising. It is because of this remarkably efficient system that less than 2% of the

population of the United States is able to produce more than enough food to feed the entire nation.



(Huang, 1)

Currently, the agribusiness industry is reshaping the agricultural landscape by transitioning the world away from traditional agricultural production and distribution techniques to a system of “more closely coordinated and better planned linkages between agribusiness firms, farmers, retailers and others in the supply chain”. (Agribusiness, 1) Also, the agribusiness sector has seen consolidation and power centralization in what has become known as “the big four”, with the four largest firms (Archer Daniels Midland, Bunge Limited, Cargill, and Louis-Dreyfus) controlling between 75% and 90% of the total market. (Lawrence, 1) The exact value is somewhat difficult to

calculate because two of the four firms are privately held and do not disclose exact figures.

Modern agribusiness has many supporters as well as detractors, but few can argue that the highly efficient and coordinated system has played an enormous role in making modern society possible. With such a small percentage of the population must be involved in food production, the vast majority of people are able to work in other fields and specialize in areas that match their skills. This also means that any potential positive changes made to the agribusiness industry would impact the whole of society, and would have vast and far reaching ramifications. Just as when the last disruptive innovation that impacted this industry, industrialization and mechanization of farming, gave rise to the modern middle class, any disruptive innovation will have an incredible impact, not just on agriculture, but on the world as a whole because agriculture and agribusiness touches the lives of every person living on the planet. Simply put, everyone needs to eat and for most of the world, agribusiness is what makes it happen.

Part 3: Data Collection and Analysis

During my freshman year of undergraduate study, I found my passion in the field of agribusiness, specifically in finding ways to improve it to better serve the world. As part of my Management Information Systems degree, I took classes that dealt with ideas like disruptive innovation, information systems, enterprise resource planning, and other areas, where I quickly saw ways that these groundbreaking technologies and concepts could be applied in ways that would improve the lives of millions. Agribusiness may not have the same reputation for excitement as other fields like internet services, with companies like Google and Apple, but it directly the life of nearly every person living on the planet, meaning that any positive change made to this industry would have an amazing effect.

I began collecting information, through online articles, case studies, reports and files on the industry as well as on the major companies operating in the agribusiness industry. I

also carefully examined the financial data for several of the firms as part of accounting projects, and the management practices for management classes. As I collected this information, I applied it to the work I was creating in MIS classes, particularly in terms of the disruptive innovation models. As this body of knowledge grew, a picture began to emerge, one of an industry that had been stagnant in terms of innovative growth, and one that had ignored the changes that were taking place in the business world around it.

Having found an interest in agribusiness, I decided to work in the industry and see first hand how its culture would impact its ability to take advantage of the remarkable changes that were spreading in other areas. In the summer of 2011, I worked as an intern for the Archer Daniels Midland company, one of the largest corporations in the agribusiness industry, as a commodities merchandiser. This experience cemented my interest in the agriculture and agribusiness field, but also gave me valuable insight into how workers and managers, not only at ADM, but in the industry as a whole understand and react to new ideas and thinking.

This paper combines the secondary research collected from various sources that gives a detailed overview of the agribusiness industry as well as several examples of disruptive innovation taking place within it, with primary research gathered while working directly in the field, allowing me to gain a first hand observation of one of the largest players in this market, to see exactly where their organization stands in terms of readiness to these changes as well as how their culture will impact their ability to embrace and accept these shifts.

Part 4: Scenario Analysis:

To demonstrate the impact of disruptive innovation on the agribusiness industry, I will apply the concepts as explained by Clayton Christensen and demonstrated by Nicholas Carr through a set of scenarios that capture the three most likely outcomes for companies operating or seeking to operate in this industry. The first scenario is that of transition, where a firm that operates in the business environment as it exists today shift

and adapts to benefit from the disruptive innovation. The alternative for preexisting firms, who fail to transition, is outright failure. Lastly, as with this situation in any industry, there are always new firms who start and develop to take advantage of the drastic changes facing the current market dominators. These startups are the third scenario and have many powerful opportunities as well potential pitfalls that add risk to the high rewards enticing them to enter and disrupt the market.

Transition

In Nicholas Carr's example of disruptive innovation and the different experiences that companies encounter as they either adapt or fail, the idea of transition is perhaps the most challenging. Rather than starting fresh and having developed alongside the new technology like new start-up firms do, companies who undergo transition must work to shed years if not decades of outdated strategy, obsolete training, and thick bureaucracy in order to radically reshape themselves to be competitive in the new business landscape.

Nicholas Carr gave the example of factories transitioning from the then state-of-the-art steam powered overhead belt drive, which in its own way was an incredible revolution and allowed for the creation of large scale manufacturing, to the more efficient and flexible electric drive system. This new innovation enabled factories to be laid out according to how production actually moved, rather than being tied to overhead rods and pulleys. It also allowed individual stations to be shut down and repaired, whereas the previous system required the entire factory's power supply to be terminated before work could begin on a single machine. The new electric method was clearly more efficient and productive, but factories who were already operating had found great success with the belt drive, and had years of experience and were comfortable with it. Some firms did recognize electrification's advantages and incredible potential, and decided to make the switch. These were the firms who transitioned to the new innovation and would ultimately be spared as the industry leaders became unable to compete with newer facilities and were eventually pushed out of the market.

Carr's example serves as a powerful cautionary tale of firms who believe that their current technology or processes are "good enough" and shows that firms in all industries must embrace progress and innovation rather than ignore it if they wish to survive.

One of the best examples of a firm recognizing this transition and undergoing a transition is one of the largest companies on Earth, yet not one that is commonly associated with the agribusiness industry. With \$132 Billion of grocery sales in 2009, Walmart is the largest grocery retailer in the United States. It operates on such a massive scale that often times, its actions and policies dictate the direction of the entire industry. Since its initial movement into the full service grocery industry with the development of its "super center" model, Walmart has quickly grown to dominate the grocery retailing industry, and now generates over 50% of its annual revenue from grocery sales. (Zimmerman, 1)

Walmart growth has not been limited to the grocery market, it is now the largest private employer on Earth, and has nearly 10,000 stores. By the mid 2000's, the company was beginning to recognize that its incredible success and enormous size had also created enormous challenges and opportunities for real change. In 2005, then CEO H. Lee Scott delivered his vision for the future of the company, highlighting a new focus on environmental impact and sustainability, as well as on growth and efficiency. Scott made his point clear by stating "Environmental loss threatens our health and the health of the natural systems we depend on... as one of the largest companies in the world, with an expanding global presence, environmental problems are our problems." The CEO then announced a plan to help its suppliers in China use fewer resources and be more productive. The company also laid out a set of long term goals for its operations and for its suppliers who support them. It plans to move toward:

1. being 100% powered by energy from renewable sources
2. generating zero waste

3. selling products that sustain resources and the environment

It was clear that the management of Walmart now understood the close connections that the company share with the planet, and how it had grown to a size where it must consider the outcomes of its actions. Walmart has also begun working directly with its food producers and suppliers as well as coming up with innovative new solutions to marketing and distributing food products to customers.

One of Walmart's key growth markets over the past decade has been China. Since the company first entered the Chinese market in 1996 (Wal-Mart, 1), it has risen to be one of the premier retailers in the country, representing western culture to a new and burgeoning middle class. Although the Chinese market still represents a tiny portion of Walmart's global revenues, the company sees its incredible growth and potential and understands the importance of establishing its presence in the market. Walmart has also used the Chinese market as a sort of testbed for new ideas and concepts, knowing that market is more forgiving and has less of a historical and cultural bond as its core American market. One such innovative concept has been the "Direct Farm Program" that Walmart created in 2007, that works directly with farmers to form cooperatives. These cooperatives allow the farmers to deal directly with the larger buyers, like Walmart, and also removes inefficient middle parts of the supply chain that add cost but not value. This program also has another significant benefit: "by dealing directly with farmers, [Walmart] is better able to control the standards of food it advertises as green or organic", which is especially important in a country like China, where food safety has been an issue in the past. (Schell, 1)

The Direct Farm Program is a clearly innovative strategy that Walmart has developed to tackle issues of food safety and environmental concerns, and shows that Walmart understands that it must be innovative if it wants to maintain its position as the largest retailer in the world.

Walmart is also using the disruptive power of information technology in its quest to continue its incredible growth. As the largest grocery chain in the country, Walmart commands nearly 33% of the US market (compared to Kroger at 9%, Safeway at 5%, SuperValu at 4% and longtime rival Target at 3%). But as the internet increasingly becomes one of the primary shopping tools for customers, Walmart recognizes that it must consider all future possibilities. The company has created an online service that it is testing in certain markets that allows consumers to buy groceries online and have them delivered to their homes. While this model has been attempted in the past, without much success, Walmart believes that it can leverage its capabilities in supply chain management to compete even more fiercely with traditional grocers as well as other online firms offering similar services, like Amazon and Fresh Direct. When asked about the company's attitude toward innovation, senior vice president and general manager of Walmart.com Steve Nave explained "One of the great things about Wal-Mart is we'll put something out there, test and learn from it...I would say nothing is off limits". (Clifford, 1)

Walmart clearly embodies the idea of a company that understands transition and is willing to undergo the process. It has worked to make innovation a strong part of its corporate culture, and recognizes that much of its success can be attributed to previous innovations, like ultra efficient supply chain management and low cost through bulk purchasing. Walmart has also moved very quickly out of its original market of dry goods retailing into virtually every retailing market, including grocery, where it has become a one of the most powerful firms in the consumer-facing side of the agribusiness industry. (Agribusiness being, as previously defined, as all businesses involved in the production of food, and grocery retailing being the critical final link between the seed and the consumer.)

Just as in Carr's example of the factories transitioning toward electric drive, Walmart has the option to partially switch elements of its operations to a new strategy where it will see some but not the majority of the benefits, or to transform itself and gain all of the advantage that this disruptive innovation can offer. While it is still early in the overall transformation process, the actions and decisions of Walmart's management team are

very promising. The managers clearly recognize the changes that are taking place, and are willing to make the short term sacrifices to profitability to ensure long term success.

By taking a direct involvement in the production of their food, through the innovative Direct Farm Program in China, and in leveraging powerful information technology tools to create a new method of distribution to customers, Walmart is transitioning out of the old “brick and mortar retailer” that only focuses on basic buying and selling, and into a far more powerful and competitive form, where it creates stronger, direct relationships with producers and consumers to deliver a better product, more efficiently, with less impact on the environment.

Failure

The modern agribusiness industry is dominated by four very large corporations that control the majority of the market and set the general tone for the industry. These companies, Archer Daniels Midland, Bunge Limited, Cargill, and Louis-Dreyfus, all share similar backgrounds and operating structures, focused on the acquisition of basic raw materials in the form of crops from farms, the processing of these basic raw materials into more valuable ingredients, chemicals, and products, and the selling and distribution of these processed products.

During the summer of 2011, I worked as an intern for one of these companies, Archer Daniels Midland, and experienced first hand a unique culture and mindset that confirmed my suspicions backed by research conducted over the prior two years as part of my degree in Business at the University of Montana, as discussed previously.

Being a large corporation, the Archer Daniels Midland company is faced with many challenges in terms of being innovative. Large corporations typically suffer from vast bureaucracies that stifle innovation and prevent creativity from spreading. Also, established companies often find it difficult to transition away from legacy processes and systems that have become entrenched in the corporate culture. These factors build

on one another to make it extraordinarily difficult for these organizations to move forward and take advantage of new processes and systems that can be vastly more efficient or profitable than existing methods.

The Archer Daniels Midland company, like nearly all firms operating in the agribusiness industry, relies on software and databases to store and retrieve information about sales, inventories, production, and other elements associated with the movement and processing of grain and other crops. This software, however, is based on technology that was developed in the 1960's and has long since reached the limits of its capabilities, especially when compared to the world of alternatives that are available. While this software is in use by many of the Fortune 500 companies, in ADM's case, it is not able to handle the needs of the organization.

Rather than using a modern interface with windows, icons, menus and pointers (WIMP), the software presents all data in plain text form, as either green or blue text on a black background. All commands are text based as well, necessitating that users memorize all commands and function key actions. This requires significant learning times for users, and allows for errors in data entry. Also, because the software is outdated, it is unable to run natively on modern hardware, forcing the system to be run with an emulator which is not as efficient or stable. Lastly, the software lacks the most basic data analytics tools, and, as ADM is using it, is unable to determine simple averages and trends. The company instead chooses to have interns calculate these values by hand with paper tape calculators. (Internship, 23-37)

When asked about the software's lack of capabilities, all employees recognized its severe shortfalls and even how more modern tools could complete these tasks in less time with greater accuracy. (Internship, 8-9) All employees also expressed anger at times about the interface and stability issues. But when questioned about the possibility of using something better, the employees became defensive, citing how the existing system was "just what [they] use and that the only option was to get used to it". (Internship, 59) Rather than innovate to solve their problems, employees at ADM have

chosen to ignore them. Part of the problem certainly lies in the inability of the employees using the software to voice their issues to management who would be able to make necessary changes, as evidenced by management's insistence that "ADM is one of the largest companies in the world, and [the software] is good enough for ADM, and good enough for the world" (Internship, 15, 59).

In fairness, most of the companies operating in this industry face a similar situation, where a dependence on legacy software has created an inability to move forward without significant time and capital expense to modernize. However, in discussions with another firm, the medium sized Columbia Grain, which uses a similar text based data management system, recognized the problems and limitations of their legacy software and showed intentions to migrate to a more capable software.

In Nicholas Carr's example of the factories transitioning to electrification, there were many large firms that fell into one of two categories, firms that either 1) tried to adapt and failed, or 2) ignored the changes taking place, could not compete and were left behind. Large companies, in particular, tend to be at greater risk for falling into these two categories because their large size and bureaucratic nature makes it hard for them to foresee dramatic changes and accept them, often leading them to be outcompeted by new companies and companies that have made the transition who are able to take full advantage of new innovations and be more efficient and productive. As it stands, the Archer Daniels Midland is following this precarious path, and will likely face difficulty as the rest of the industry adapts and moves forward.

Looking at the history of disruptive innovation, this attitude and line of thinking nearly always foreshadows failure. As companies begin to see how far behind they are, they transition from unawareness to denial. A similar case would be Kodak, which for years ignored the oncoming threat of digital photography as a disruptive innovation in their industry, shifted to denial as they began to understand how completely they had missed the jump to the next generation of imaging technology and famously continued to decree that consumers would always need film, and later, would always print

photographs. As it became more apparent that this was not the case and that the industry moved on, the company that was at one time represented what it meant to capture a memory simply ceased to exist.

Replacement

The last potential scenario to be examined is the case of replacement. This case occurs when newcomers rise to compete with the dominant firms. At first glance, this appears to be an impossible situation, where the existing firms have a clear upper hand and an any start up firm would quickly find it impossible to compete. However, Christensen's analysis and Carr's examples show that quite the opposite can and often does happen.

Existing firms have several obvious advantages. They have an established place in the market that generates consistent profits. They also generally have a very good understanding of the industry and brand recognition. Lastly, they tend to have plenty of cash, generated from years of steady profits, that enables them to acquire expertise and technology that they need to operate.

These dominant players also have some key negative factors working against them, factors that upstarts are able to avoid and take advantage of. These include large bureaucracies that have developed as the company has grown, as well as a firm corporate hierarchy that tends to limit innovation and creativity because it cannot be quickly realized as profit. Startups also have the advantage of "growing up" with the innovation. With Carr's example of the factories, the new companies that came into the market were led by people who had been a part of the innovation of electrification and had a native understanding of its true potential and capabilities, unlike the managers at older firms who struggled to understand the importance of this new development. Likewise, people who have been a part of the development of information technology, and who have seen and felt its incredibly disruptive capabilities, have an understanding of its importance that is an order of magnitude greater than someone who is not experiencing it first hand.

One such example of a start up firm using information technology as a disruptive innovation in the agribusiness firm is in the example of FarmScan AG's development of variable rate irrigation based on geographic information systems data. Traditionally, farmers have used center pivot irrigation to water large areas of land and have done so by applying moisture equally across the entire field. While this method is effective, it is also incredibly wasteful and imprecise. Some areas of soil retain moisture better than others, meaning that with uniform coverage, some areas will be too moist, and others will be too dry.

For years, there was no good solution to this problem, but Dr. Craig Kvien of the University of Georgia realized that information technology has progressed to the point of being capable of solving this problem. He has worked with FarmScan AG, an Australian company that manufactures agricultural equipment, to develop "variable rate irrigation", where individual controllers on the end of each sprayer combined with a computer system loaded with geographic data about surface landscape and moisture levels, adjust the spray levels as the irrigator moves around the field. This team is using information technology to deliver a better quality product with less resources, and has the potential to radically change the market in large scale irrigation. (Agriculture, 1)

While this technology is costly, between \$5,000 and \$30,000 per irrigator, it enables farmers to get more productivity out of their land while using fewer resources, up to 15% less water and fertilizer consumption, due to less waste through runoff. In the article on variable rate irrigation, the author notes in a correction that Zimmatic and Valley Irrigation, two of the largest firms operating in the large scale irrigation industry, are not working with the team from FarmScan AG to deploy this technology. This clearly mirrors the example of how disruptive innovation occurred within the hard drive industry in Christensen's text, with a new technology being developed with significant benefits such as higher density or smaller size, but significant initial costs which deterred market leaders from initiating further development. (Christensen, 3-68) Here, the two dominant firms can clearly recognize the impressive abilities of this technology to make

agriculture more efficient, yet are daunted by the costs which will inevitably decrease as the technology is developed and more widely adopted.

The irrigator example is not the only area where new firms are using information technology to disrupt and improve the agribusiness market. Another group, based out of Germany, has developed systems to use imagery captured by satellites to build out maps of fertility in fields based on variations in the visible light spectrum. (Dumiak, 1) This technology will hopefully give farmers better insight into the actual conditions of their fields and will allow them to more precisely manage their crops, reducing the need for chemical fertilizers and pesticides. Yet another group is studying the use of mobile phones for relaying important information to farmers in developing countries where access to expensive and powerful information systems is rare. This technology is expected to allow farmers to “reduce food waste by enabling smart logistics, tracking of produce and monitoring of food quality”. (Lacy, 2) Each of these examples shows an extraordinarily innovative group that has “grown up” as modern information technology has developed, and that is using it to radically improve agriculture and agribusiness while more conventional firms fail to see its potential.

Christensen clearly demonstrated how often market leaders are unable to see the potential of new developments and are afraid of a new innovation cannibalizing their existing sales and threatening their position as a market leader. In his section on “Why Great Companies Fail”, Christensen examined this concept of protectionism ultimately leading to paralysis, and why many of the greatest innovations come not from the companies who have the financing and expertise to develop them, but from new start up firms who are not encumbered by this fear of potential failure or harming existing and profitable product lines.

Just as in Christensen’s examples, where Control Data Corporation got to be so large and successful that it was unwilling to invest in developing the new 8 inch hard drive because it saw the significant capital requirements of research and development, as well as the potential impacts it could have on their very successful current product

offerings, the two market leaders in the irrigation industry are unable to discover the amazing ability of information technology to completely improve processes to be more productive with less resource cost. (Christensen, 54) Instead, it has taken a small firm with vision and thorough understanding to challenge the status quo and introduce a remarkable improvement on the existing model. In the hard drive example, Control Data Corporation was essentially blinded by its own success, unable to see beyond its current position as a market leader, only to allow a start up firm to find the niche they needed and to usurp them with newer, smaller, and better technology. Here too, we see companies who lead the market yet are unable to recognize what is coming and how to incorporate it into their product. Christensen began his book by asking himself the question of how mighty firms like Digital Equipment Corporation and IBM could possibly fall, and discovered the answer lay not with management as many suspected, but rather in the cultural shift that occurred once companies found success, and their newfound unwillingness to innovate and push the market forward. (*Opportunity*, 1)

Conclusions:

In 2007, Steve Jobs introduced the world to an innovation that would forever change how people accessed information, entertainment, and communication. The individual developments that made it all possible appear simple on their own, like a better touch screen or more capable web browser, but combined, they upset the entire existing mobile device industry. Companies who were once the unquestioned market leaders like Motorola, Nokia, and Palm suddenly felt as if the world had been turned on its head and immediately had to catch up. Some did, like Motorola transitioning to Google's Android mobile operating system. Others failed, like Palm who tried to ride on its existing offerings before trying too late to reinvent itself. Still others, like Nokia, are in the process of transition, with an attempt to transition over to Microsoft's Windows Phone platform, but are facing incredible challenges from the new entrant, Apple, who gained a strong advantage by being first to a market that they created. Disruptive innovation is not a new phenomenon, but the smartphone revolution is one of the

clearest examples ever demonstrated of its intense and incredible power to topple empires and create new ones in their place.

Over the course of my years as an undergraduate studying Management Information Systems, as well as independent research and experience within the industry, I have carefully analyzed the phenomenon of disruptive innovation in terms of how it will impact the agribusiness industry. The disruptive impact of the information systems revolution was initially felt within industries directly connected to information technology, but has since rapidly spread outward in all directions and will touch all aspects of our economy. At first, only firms that dealt with computing hardware were felt the force of this disruptive innovation, industries like the hard drive manufacturers and main frame computer developers as mentioned in Christensen's book. But as the true potential of information systems has been realized, its impact has expanded, first to areas linked to computing like cellular phones and internet services, then to another level outward with media players and to music, and movies, and books. Much like a pebble dropped into a calm pond, disruptive innovation spreads from its initial source to eventually cover all industries.

Agribusiness will not be immune to the impacts of this disruptive force, and actually has a lot to potentially gain in the ways of efficiency and productivity. This process is nothing new; the same scenario played out with the advent of mechanization of agriculture during the last great disruptive innovation: the industrial revolution. In that case, the world saw tremendous increases in productivity, allowing a previously unimagined percentage of the population to be supported by a small percentage who were able to manage much greater amounts of acreage. This transformation gave rise to much of our current society, with large urban populations and strong service and manufacturing sectors. While information systems has had an incredible impact on other areas, giving consumers access to a world of information at their fingertips, its potential for helping to solve our current resource and food shortages is what makes it truly crucial to be understood.

With recent news, the process appears to already have begun, with the Archer Daniels Midland company announcing in early January of 2012 that it was beginning a strategy of streamlining corporate structure and boosting competitiveness by eliminating 1,000 employees. Fellow member of the “big four”, Cargill Inc, announced its intentions to reduce its employee count by 2,000. (Berry, 1) Both companies cited sluggish economies and a need to improve competitiveness with other firms operating in what has become a global economy. Just as Christensen and Carr demonstrated, these large firms have grown to the point of finding it hard to adapt and compete as quickly as other, smaller firms who are more agile and can respond more quickly and thoroughly to changes as they occur.

In this thesis, I have outlined the three likely scenarios of companies operating in this industry as it undergoes a transformation through the disruptive innovation of information technology. These scenarios, transition, failure and replacement are the three options, with the first two applying to firms currently existing, and the third applying to companies who enter this market. These scenarios have played out in every industry that has been affected by this, and all previous, disruptive forces.

Summarized in three main points, disruptive innovation in agribusiness:

1. is important because it has the potential to impact the lives of a very large amount of the global population currently facing food and resource shortages.
2. has occurred in the past (mechanized agriculture during industrial revolution) with dramatic beneficial impacts to humanity.
3. will drastically affect firms operating within this industry who are not able to adapt and transition to accept these advancements and changes.

Steve Jobs of Apple Inc. said it best, every once in a while, something comes along and changes everything. This phenomenon is known as disruptive innovation. In an industry as vital as the agribusiness industry, this process has the potential to unleash incredible positive changes, but at a great cost to those firms that fail to understand, anticipate,

and adapt to it. Given this analysis combined with these scenarios, it is clear that great change is coming and that it is up to the existing firms as well as potential startups to maximize the value from these developments and use them to further the mission of the agribusiness industry, to feed the world.

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