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Growth Possibilities Found, Taken, and Lost

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Growth Possibilities Found, Taken, and Lost ¹

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1. Introduction

In aspiring for long-term growth, firms must simultaneously pursue various exploration and exploitation activities (Gupta, Smith and Shalley 2006, March 1991). Such ambidexterity is central to decision-making for long-term growth and is difficult to accomplish effectively (*BusinessWeek* 2007, He and Wong 2004, Tushman and O'Reilly 1996). It results in growth possibilities being found and taken, and inevitably, in some being mistakenly lost and growth and profits forgone. Xerox is well-known for having missed exploiting pioneering opportunities created in its R&D labs that were lucratively exploited by others (Chesbrough 2002). Almost not entering new businesses, or growth possibilities taken after significant lapses of time (Dickson and Giglierano 1986), are also lost opportunities because they too result in growth and profits forgone and allow competitors time to get entrenched. Polaroid and Kodak were both late in taking growth opportunities presented by new digital imaging technology (Ma and Karri 2005, Tripsas and Gavetti 2000). IBM was similarly slow in recognizing the promise of both minicomputers and personal computers, and DEC's missing of the latter led to its demise (Christensen 1997). Decision-making processes behind even successful choices reveal how perilously close decision-makers can come to not making them and almost missing valuable opportunities. The multi-billion dollar drug losartan for hypertension was almost not developed because managers could not see its market potential (Bhardwaj 2006), and DuPont almost left unexploited the vast profit potential of its pioneering sulfonyleurea herbicide when managers erroneously concluded that the area of chemistry on which it was based had yielded all the new products it could (Bhardwaj 2007).

Lost opportunities are decision-making reality that worry managers. They can result in dropped stock prices and the exit of CEOs presiding over forgone profits and growth. The phenomenon is more widely prevalent than may be evident from popular business writings and the academic literature due to survival and selection biases in samples (Denrell 2003), and the difficulties of gathering valid data on choices that could have rightly been made but were not. Long-term growth and transformation have thus been mostly studied in terms of choices made. But rigorous understanding of how they are actually

achieved will remain incomplete, and could even be misleading (Denrell 2003), unless studies include choices that could plausibly have been made but were not (Ferguson 1997, Weick 2007).

Studying lost opportunities in isolation can similarly result in incomplete or biased understanding. Because they are part of a larger set of corporate endeavors (Chesbrough 2002, Tushman and O'Reilly 1996), data permitting, they are best studied as part of the complete set of considerations and choices. This is especially so in studying long-term growth, which requires continual and multiple innovation and entrepreneurship efforts for discovering and creating growth possibilities (Bhardwaj, Camillus and Hounshell 2006), of which some are taken rightly or mistakenly, and others not, also rightly or mistakenly (Figure 1). Employing such comprehensive data, this paper investigates how growth possibilities are found, taken, and lost, and contributes to the decision-making literature on corporate entrepreneurship.

1.1 Losing Opportunities. In pursuit of long-term growth, many firms, particularly those driven by science and technology, follow continuous research and continual innovation and entrepreneurship (Bhardwaj, Camillus and Hounshell 2006). Multiple, simultaneous such efforts may be found at any point in time as well as spanning long periods. The creation and discovery of growth possibilities through scientific research, innovation, studies of markets and technology is termed exploration. Exploitation, in this paper, is the subsequent pursuit of some of these growth possibilities in the form of new products in existing businesses or new business entry. Together, these activities constitute entrepreneurship (Shane and Venkataraman 2000). Such continual corporate entrepreneurship for long-term growth involves distant returns – a series of considerations and choices made under high uncertainty and ambiguity, where important information and events emerge unpredictably over time, and desired outcomes are attained over long periods, if at all (Bhardwaj 2000). Making entrepreneurial decisions under these distant returns conditions is especially challenging and can result in growth possibilities being lost.

Levitt (1960) raised the alarm of lost opportunities and consequent decline by observing that firms that defined their markets narrowly in terms of products rather than customers missed opportunities from technological and market changes. Hayes and Abernathy (1980) followed, noting an emphasis by firms on cost reductions and short-term gains as reasons for their long-term decline while competitors

created and exploited new opportunities with longer-term, riskier investments for novel innovations and competitiveness. Market and technology explanations for missed opportunities were further developed by Christensen and Bower (1996) who showed that established firms chose not to invest in emerging disruptive technology because it resulted in products with lower performance than those they sold and current customers did not want such products. Instead, new firms invested in the emerging technology. Over time, the technology improved and so did the performance of products based on it, eventually replacing the earlier technology and products. The older, established firms often disappeared from having missed the new growth opportunities presented by the disruptive technology.

Others have looked inside the firm for explanations. Cultural and structural inertia were proposed for a firm's inability to re-orient itself in the face of discontinuous change and thus missing opportunities (Tushman and O'Reilly 1996). As also were attitudes towards failure (Dickson and Giglierano 1986, Mullins and Forlani 2005). Taking an opportunity may be delayed or missed in allowing time for important uncertainties be resolved to reduce the chance of failure because failure can be more salient to some decision-makers than rewards of success. Failure is more easily quantified, evident, and attributed to an individual's poor choice than is success. The latter is often attributed to good fortune. And lost opportunities are less easily quantified, evident only after a considerable lapse of time, and harder to attribute to any single decision-maker. Missing an opportunity may thus result in less damage to one's career than risking taking one that later proves to be a failure.

Studies of decision-making processes added micro explanations of how opportunities were lost. Chesbrough (2002) discovered that inventions at Xerox were evaluated for their potential to contribute to existing businesses. Those reflecting novel growth possibilities were abandoned for failing to meet this criterion. Other firms pursued them and benefited. This paper continues the investigation of decision-making processes but looks at DuPont which, unlike Xerox, was actively trying to explore its way into new fields (Bhardwaj, Camillus and Hounshell 2006), so a growth possibility's lack of fit with current businesses did not automatically make it unattractive, yet DuPont ended up missing opportunities. The explanations developed here extend another line of inquiry which showed that Polaroid managers'

cognitive beliefs influenced the decision-making process, direction of search, and new capabilities development, resulting in the company missing the industry-transforming digital imaging technology (Tripsas and Gavetti 2000). By the time it exploited this opportunity, competitors were well-entrenched. This paper goes beyond beliefs and uses field data to develop theoretical explanations of how decision-making heuristics (Tversky and Kahneman 1974) and power (Finkelstein 1992) influence continual exploration-exploitation for long-term growth and result in growth possibilities being found, taken, and lost (Figures 1 and 2). As Shane (2006) has argued, there is still a paucity of theoretical explanations of the entrepreneurial decision-making process.

Various studies have found the use of heuristics by entrepreneurs and there is evidence that they use them more than managers (Barney and Busenitz 1997). These studies have investigated opportunities taken, not those lost, and were based on settings and methods that did not explicitly deal with making choices for long-term growth. Although their findings cannot be presumed to transfer (Zahra 2007), heuristics may play a bigger and inevitable role in continual corporate entrepreneurship for long-term growth because the distant returns conditions noted earlier are stronger than the uncertainty conditions under which biases and heuristics have been shown to play a natural and simplifying role (Tversky and Kahneman 1974). Their use can lead to good decisions and bad (Tversky and Kahneman 1974), and results of this study show that heuristics do result in both opportunities being taken and lost. Because risk-taking is context-dependent (Kahneman 2003), replication of behavioral decision theory findings in distant returns settings, in the absence of field evidence, cannot be presumed. The findings were typically derived from lab experiments with 1-shot choices disconnected with others at a point in time and over time, which is contrary to actual decision-making for long-term growth. As Axelrod and Hamilton (1981) persuasively showed, when decision-making changes from a 1-shot game to repeated games, so does behavior. Lab findings are also based on choices made from among given alternatives but central to decision-making by entrepreneurs is their discovery and creation of opportunities (Shane and Venkataraman 2000). These studies have characterized risk in terms of probabilities but managers instead think of risk in terms of potential loss (March and Shapira 1987). Moreover, long-term growth

decisions are more about uncertainty and ambiguity than probability-based risk (Bhardwaj 2000). As Kahneman (2003) noted, prospect theory is mainly about short-term outcomes, while March and Shapira (1987) observed that although there is empirical support for risk-taking in adversity they were skeptical that major innovations stem from “misery”. Search and risk-taking for long-term growth have indeed been found to depart from predictions of behavioral decision theory (Bhardwaj, Camillus and Hounshell 2006). Finally, in developing their arguments for bold forecasts and timid choices, Kahneman and Lovallo (1993) cautioned that their work applied to decisions of intermediate size and individual decision making, not organizational. These conclusions suggest the need for field research to develop theory.

The above arguments also highlight the necessity of looking at decision-making processes behind both exploration and exploitation to understand how growth possibilities are found, taken, and lost. And because decision-making is about entrepreneurship, it is also essential to relate both activities to risk perceptions and risk taking, something the literature has failed to do (Gupta, Smith and Shalley 2006). Studies in exploration-exploitation have not looked at risk taking and studies about the latter have looked at either exploration or exploitation but rarely both.

Accordingly, to understand how firms find, take and lose opportunities, this paper develops theoretical explanations of decision-making process from a field study. It uses comprehensive archival exploration-exploitation decision-making data spanning 20 years that allow a valid analysis of lost opportunities. The next section describes the research methods. Subsequently, process theory explanations are developed from field data and linked to the literature. The final section notes the study’s limitations in applicability, suggests ideas for further research, and describes implications for practice.

2. Methods

2.1 Archival Case Research Method. To develop theoretical explanations of the decision-making process by which growth possibilities are found, taken, and lost, case research and historical methods using archival data were adopted because they are well-suited for investigating processes that span long periods and under-researched complex phenomena (Cuff 2002, Eisenhardt 1989, Eisenhardt

and Graebner 2007, Gaddis 2002, Hounshell 1999). The counterfactual method of business and economic historians was used to analyze lost opportunities (Cowan and Foray 2002, Ferguson 1997). These methods required using rich data to develop theory, and not testing hypotheses based on a limited literature; and using the research question to guide data collection from a theoretically relevant setting. More important than the number of cases is the richness of data used in developing theoretical explanations (March, Sproull and Tamuz 1991, Weick 2007). The research question was investigated by analyzing the exploration and exploitation efforts of the DuPont Company from 1902 to 1921², when the company considered and pursued numerous growth possibilities (Figure 1) and transformed itself from an explosives company to a broadly diversified chemical company. An extensive archival collection of DuPont's meticulously detailed internal documents from this 20-year period have been preserved. Combined with contemporaneous newspaper articles, they allowed the study of choices made and why, and those considered but not pursued and why. Using these documents, a comprehensive case study was written on all the corporate research, innovation, planning, and entrepreneurial efforts, or all exploration and exploitation activities. From the relevant set of events in the comprehensive case study, theoretical explanations of the phenomenon were abstracted and generalized (Gaddis 2002).

2.2 Setting. Decision-making at the DuPont Company from 1902 to 1921 provided an ideal setting to investigate the research question. Established in 1802, it was solely in the explosives business for its first 100 years. On February 26th, 1902, the family partnership was dissolved and a new entity incorporated (Chandler and Salsbury 1971). An Executive Committee, comprising about a dozen senior managers, a few of whom were from the du Pont family, was formed to lead the new company. In the next 20 years, exploration-exploitation moves made by Executive Committee members, managers, and scientists grew and transformed DuPont from a badly-performing explosives company to the biggest and most profitable one in the U.S., and then to a giant multi-business enterprise, and laid the foundations for

² Additional financial data and data on context, search process, growth possibilities generated, and subsequent decisions and outcomes can be found in the online supplement to Bhardwaj, Camillus and Hounshell (2006) available on the *Management Science* website at http://mansci.pubs.informs.org/ecompanion_06.html. A narrative case history is available from the author. Detailed histories of DuPont during 1902-1921 can also be found in Chandler (1962), Chandler and Salsbury (1971), Hounshell and Smith (1988), and Taylor and Sudnik (1984).

its continued growth (Chandler 1962, Chandler and Salsbury 1971, Hounshell and Smith 1988, McCormick and Folsom 2003). Setting aside its massive sales and profits from the First World War (WWI), revenues more than tripled from \$26.1 million in 1904 to \$84.6 million in 1925, and net income almost quintupled from \$4.4 million in 1904 to \$24.9 million in 1925. DuPont's growth efforts were greatly aided by its remarkably high cumulative earnings of \$236.187 million from WWI sales.

In its pursuit of long-term growth, the company launched multiple, simultaneous, and continuous exploration-exploitation efforts. The Executive Committee created the Experimental Station to pursue long-term scientific research on products, technology, and processes, and the Development Department to conduct planning, technology screening, firm acquisition, and market studies. The work of the two units dealt mainly with exploration and supported decision making by the Executive Committee, including the exploitation move of new business entry. Despite a single company setting, the study was not limited to a single instance of decision-making but comprised several efforts over 20 years (Figure 1) involving many senior-, mid-managers, and scientists from three organizational units. Some of these took the company in new directions and were a significant departure from its existing businesses.

The setting allowed controlling the effect of fund shortages on innovation and entrepreneurship. DuPont did not cut expenditures for the Experimental Station and Development Department, even when sales and profits were in decline, and documents do not indicate any evident shortage of funds for new business entry. The company had an explicitly stated policy of pursuing distant returns endeavors, as in the Experimental Station's work, and recognized that "great" rewards needed considerable resources. In the 20 years studied, the company also faced all phases of the economic cycle and an antitrust lawsuit.

2.3 Data. DuPont permitted unrestricted access to its vast collection of internal documents, running into hundreds of linear feet of stacks, archived at the Hagley Museum and Library in Wilmington, Delaware. Those used in this study dealt with the works of the Executive Committee, Experimental Station, and Development Department, and detailed deliberations regarding exploration and exploitation from 1902 to 1921. The collection included memos, summaries of Executive Committee meetings, letters, and an extensive collection of detailed reports on the studies performed by the Development

Department and Experimental Station that were used in the Executive Committee's deliberations. The documents described conditions and considerations as they unfolded and the reasons behind them, and often contained information on future expectations. Because they were written for internal use, they were a valid source of information on actual decision-making and on the views of decision-makers at the time of the deliberations. In addition to the documents originating from three different units within the company, multiple documents over time from all three sources contained information on the same deliberation, aiding triangulation. Hundred of articles from the *Wall Street Journal* and the *New York Times* from 1900 to 1925 that dealt with DuPont and the various industries it considered entering were used to gather additional data and triangulate that drawn from internal documents. To develop complete ex ante explanations, in collecting and analyzing data, deliberations on all exploration-exploitation activities were included. Data included all scientific research done (whether the outcomes were useful or not), all attempts at innovations (whether successful or not), all new technologies and markets studied (whether adopted and entered or not), and all deliberations of new business possibilities (whether they led to new business entry or not). These data were found sufficient for theory development.

2.4 Analysis. Understanding how and why decisions were actually made required capturing the perspective of decision-makers at that time. Analysis was thus based on facts and reasons spelled out in the documents. Risk perceptions and risk taking were based on concerns and confidence expressed in documents, how new the effort was relative to the company's experience, capabilities, and current businesses, and on industry accounts in newspapers. Growth possibilities found and those exploratory efforts that yielded none were identified from internal documents. Exploitation moves included new business possibilities taken, those taken and soon exited, possibilities discarded, those that were promising but were yet not taken (Figure 1), and possibilities almost not taken or taken with delay. The paper was motivated by understanding how opportunities were lost but data collected and analyzed were comprehensive to preclude sampling bias and to capture possible inter-linkages among choices. Although each possibility considered over the 20 years was analyzed, not each is described in the paper, which aims to develop theory not present history. The theoretical arguments developed pertain to growth possibilities

found, taken, sometimes with delay, and lost. They involved uncertainty and ambiguity. There was little uncertainty and ambiguity or disagreement about the many possibilities discarded and a few exited for low returns or being far removed from DuPont's interests. They are not the focus of the paper.

Counterfactual reasoning, used by some business and economic historians (e.g., Ferguson 1997, Fogel 1973), was adopted to investigate lost opportunities to analyze what did not happen but could have plausibly (Weick 2007). Using documentary evidence, it involved reconstructing the decision node to identify the possibility considered but not taken (Cowan and Foray 2002). The unrealized alternative was probable and plausible because it was actually considered by decision makers rather than an improbable or imaginary one imposed by the author (Ferguson 1997). Further, every growth possibility not taken was not a lost opportunity. Thus, the analytical logic was: C led to D, C' would have led to D'. If $D' > D$, then an opportunity was lost. Counterfactual reasoning was circumscribed by data from internal documents and contemporaneous newspaper articles. For plausibility of the outcomes that could have resulted if the opportunity had been taken rather than lost, the outcomes were derived using what actually happened to others who did take that opportunity (Sterling Products Co. in the case of pharmaceuticals), similar moves taken by others at that time (creation of Merck), and from the fortunes of comparably sized companies already in the industry (in the fertilizer lost opportunity).

The theoretical arguments presented next reflect the patterns of relationships among the constructs that emerged from analysis of the field data (Eisenhardt and Graebner 2007).

3. Findings

Field data show that risk taking in exploration-exploitation is influenced by initial perceptions of risk and attempt to manage four sources in a new search domain from which it is derived (Figure 2). Initial perceptions may later prove inaccurate. Decision-making heuristics also influence risk taking. Whether considerations are framed in terms of the risk of taking a growth possibility or the risk of not taking it, whether a growth possibility has few or many links with existing and future businesses, and whether the time frame considered is brief or long, all influence risk taking in exploration-exploitation.

When the work of the organization diverges significantly from the beliefs and preferences of powerful individuals, they are likely to influence the considerations in their favor. Decision making heuristics and biases and power-based influence thus affect risk taking in exploration and exploitation, resulting in growth possibilities being found or not, from those found, some are taken rightly or mistakenly taken and others that are not taken rightly or mistakenly.

3.1 Balancing Initial Risk Perceptions. In using continual innovation and entrepreneurship over time for long-term growth, decision-makers occasionally embarked on explorations in new fields, or search domains, to seek new and substantially different growth possibilities. Moves into new search domains were more likely after events caused them to expect future profit prospects to change significantly and lastingly, for better or worse (Bhardwaj, Camillus and Hounshell 2006). These moves entailed taking on significant risks, in the form of possible failure and losses (March and Shapira 1987), as they were departures from the company's current businesses and capabilities. To attenuate overall risk, decision-makers pursued those new domains that they believed allowed them to manage and balance risk from four sources within the domains. Consistent with March and Shapira (1987), risk was not reduced to a single quantifiable construct, and decision-makers' choices were based on the belief that they could exercise some control over risk due to their skills (Shapira 1995). Reflecting concerns of both future exploration and exploitation, the four sources of risk were: (i) scientific research needed to develop new products, processes, and technologies, (ii) manufacturing capabilities and infrastructure needed for new businesses, (iii) nature of competition, and (iv) growth and profit potential of markets. These initial risk perceptions influenced subsequent explorations to reduce uncertainties and discover and create new growth possibilities to be possibly exploited with new business entry and products (Figure 2).

At the creation of the new entity in 1902, DuPont had already been in explosives for 100 years. Unlike their predecessors, the new owners and managers were entrepreneurial and ambitious about long-term growth. DuPont was already ahead of others in doing research and the new management saw this activity as integral to growth and profitability. With its considerable industry experience and market dominance, it was willing to undertake risky research to invent new explosives and manufacturing

processes because it saw little additional risks from the remaining three sources of uncertainty. A similar balancing of perceived risk in exploration and exploitation led DuPont in 1903 to begin pioneering research in bacteriological fermentation and nitrogen fixation. Both were long-shot efforts with no assured payoff but the company was willing to undertake high-risk exploration because there was almost none in exploitation. Making explosives required glycerin and nitric acid and the supply of both was limited. Glycerin came from slaughterhouse waste and as a byproduct of candle-making, limiting its supply while demand for it was rising from a wide variety of industries. Nitric acid was made from nitrate of soda which came from Chilean mines, the sole global supplier. Desiring alternate sources of both essential ingredients, DuPont began researching bacteriological fermentation to create glycerin for its needs and methods to fix atmospheric nitrogen to make nitric acid. Discoveries from these long-shot explorations would find ready exploitation in-house – there was no risk of competition and markets. They would reduce a serious potential threat to the dominant business. The products could be sold outside but that was not the reason for initiating these explorations. In all three domains, high risk perceived in exploration and the willingness to take it was balanced by low perceived risk in activities associated with exploiting any growth possibilities found. Nitrogen fixation and bacteriological fermentation yielded nothing despite many years of research, but explosives research yielded novel and improved products that were profitably manufactured and sold.

Explorations for new and different growth possibilities began in the nitrocellulose search domain at the end of 1908 after the U.S. Navy, a major customer, cancelled large orders for smokeless powder and began constructing its own plants. These moves aggravated the threat posed by the U.S. Government's antitrust lawsuit filed against DuPont in July 1907. Faced with the prospect of large and permanent idle capacity, the company began searching for new businesses based on nitrocellulose, a highly inflammable explosives ingredient that was difficult to manufacture and was also used to make other kinds of products. Possessing sophisticated expertise in making nitrocellulose, DuPont believed there would be little manufacturing risk to these new businesses as the company's plants and infrastructure could be easily used for making new kinds of nitrocellulose-based products, such as

artificial leather, artificial silk, celluloid, coating materials, and films. Their markets were growing, involving little risk. Research and competition, however, presented risks. Despite its familiarity with nitrocellulose chemistry, DuPont would have to conduct research on very different products and processes. And it would have to take on new competitors where it perceived risks as ranging from low, for artificial silk, to high, for artificial leather, film, and celluloid. Given the suddenness of losing a big portion of its sales, DuPont sought new growth possibilities in the nitrocellulose search domain because although the overall risk of this new domain was higher, it was somewhat attenuated by the company's perceived ability to manage and balance risk from the four sources related to exploration and exploitation. These perceptions would later emerge inaccurate but nevertheless influenced early considerations.

With the start of WWI in summer 1914, the company was deluged with explosives orders and its production capacity multiplied rapidly and massively. By May 1915, realizing it would have immense idle capacity on its hands when the war ended, DuPont began searching for new businesses that would utilize post-war excess capacity. Among the new search domains, the most important one was synthetic organic chemicals, which included dyes, intermediates, drugs, and others. The company soon realized the very high-risk research it would have to undertake to enter and succeed in these new industries. Most organic chemicals were imported from Germany until WWI cut off their supply. With the global leader Germany isolated, there was little scientific knowledge available in the U.S. to draw upon. DuPont would have to research its way into synthetic organic chemicals. In early deliberations, it erroneously believed its existing manufacturing capabilities and infrastructure would enable smooth entry. It soon discovered otherwise, concluding it would have to invest considerable resources in also creating manufacturing capabilities. Competition and markets risks were low. There was almost no domestic supply and demand was huge. This domain, too, allowed the balancing of perceived risks associated with exploration and exploitation activities. Over time, these perceptions would again prove to be gross miscalculations.

DuPont conducted explorations in additional domains during the war years but they were far less ambitious. The domains were inorganic chemicals, vegetable oils, varnishes and paints, paper, and motor cars. With the exception of the last, whose entry decision is described later, they were seen as well-linked

with either existing capabilities in research and manufacturing or with synthetic organic chemicals that were being intensively explored. DuPont did not perceive any great risks in markets and competition in these additional search domains. Risks from all four sources were perceived as low. Subsequent entry in paints would show they underestimated competition and market risks.

Decision-making patterns over 20 years show that no new search domain was pursued where risk was high and could not be managed from all four sources: research, manufacturing and infrastructure, competition, and markets. Domains where all four perceived risks were low were explored but they also came with the possibility of low gains. More typically, domains were chosen such that the risks of exploration and exploitation were inversely related. These patterns were general tendencies. The departure from them, entry into motor cars, was due to the power-based influence of a few senior managers, some of whom were among the owners of the company. In general, decision-makers had greater sense of control and confidence in their research and manufacturing capabilities than in influencing competition and markets. They were thus more likely to take on greater risk in the former than in the latter activities associated with new search domains. The initial perceptions of risk often proved to be underestimates but nevertheless influenced subsequent exploration-exploitation choices.

3.2 Framing. Continual corporate entrepreneurship for long term growth is a distant returns endeavor (Bhardwaj 2000). A series of considerations and choices are made under high uncertainty and ambiguity, important information emerges and events occur unpredictably over time and influence the nature of exploration and potential pay-off, and desired outcomes are reached over a long period of time, if they are at all. Under these conditions, heuristics that simplify decision-making are inevitably used (Tversky and Kahneman 1974). Field data show that the various ways in which decision situations were framed influenced risk perceptions and risk taking (Tversky and Kahneman 1981) in exploration-exploitation, and thus the nature of analysis and choice (Figure 2).

3.2.1 Risks of action vs. risks of inaction. Work and choice regarding exploration-exploitation were influenced by whether growth possibilities were seen mainly in terms of the risks and benefits of pursuing them or mainly as the risk and benefits of not pursuing them.

DuPont's nitrogen fixation and bacteriological fermentation explorations spanned many years despite long odds, high costs, and not a single product emerging because the risks or costs of not undertaking them was seen as much higher than the risks or costs of undertaking them. Although consistent with March and Shapira's (1987) finding that risk is seen as potential loss, the assessment of risk was framed in terms of action vs. inaction. The company was not so much seeking a promising opportunity as preventing a potential calamity. Funds for these explorations were not cut even in times of declining sales and profits. Glycerin's and nitric acid's essentiality for explosives and their limited supplies caused serious worries about their future availability and prices. Any risk, in the form of resources spent in vain, in their pursuit seemed minor compared to the harm that could visit the explosives business from their shortages. After many years, when the risks associated with inaction vs. action reversed, both efforts were abandoned. Nitrate of soda's supply from Chile never became a serious constraint, and DuPont was able to purchase soda mines there. In the 1920s, a new French technology enabled DuPont to begin ammonia production to make nitric acid, obviating the need for nitrate of soda. Meanwhile, other research at the company resulted in its explosives needing less glycerin than before.

Given the impetus for seeking nitrocellulose-based businesses, the risk of inaction was clearer and higher than that of action. The antitrust lawsuit, the Navy's cancelling of large orders, and building its own explosives plant signaled a definite and steep drop in DuPont's sales and profits. Neither could be redressed by further growing the mature explosives business DuPont already dominated. It had to quickly find alternate means of growth. The direction of the new search was meant to attenuate risk by leveraging nitrocellulose manufacturing capabilities that were part of the idle explosives manufacturing capacity. But due to the risks of entering nitrocellulose-based businesses as new and diverse as artificial silk, artificial leather, celluloid, coating materials, boat-bottom paint, and cinematographic and photographic films, it is unlikely the company would have undertaken the risks in exploration that it did and entered some of these businesses if the risks of inaction were not far worse. Had circumstances been otherwise, the risk of inaction would have been far lower and DuPont would likely have been much less aggressive in its exploration-exploitation efforts in this new search domain. It soon discovered manufacturing was

riskier than it had anticipated. It was more complex and required new technologies and capabilities that DuPont did not have, nor could it easily acquire. Competition also proved to be higher than initially realized, especially in artificial leather and photographic films. Discouraged by the lack of proprietary technology and Kodak's hold of the market, DuPont dropped photographic films from considerations. Boat-bottom paint was discarded for its low returns. While continuing its search for the remaining growth possibilities, DuPont entered artificial leather in 1910 by acquiring a leading company that it later discovered was not competitive. But it was able to use a solvent-recovery process from explosives in artificial leather manufacture and succeeded in improving the product's quality greatly. It would, however, take a few years for the business to yield acceptable returns.

The search for new businesses begun in May 1915 to prepare for after WWI was driven by the desire to find those that would utilize the massive idle capacity that would result after the war. None could be found that suitably fit this criterion. The best possibilities only partly utilized the general infrastructure, not the specialized explosives plants and infrastructure being built to meet war demand. The search criterion was then changed to new businesses that would utilize DuPont's organization after the war and exploration expanded to include a number of new search domains. But instead of entering new businesses after the war, DuPont entered dyes and intermediates in the midst of it in 1917. The risk of not entering at that time was seen as far greater than entering. The former was vividly clear; the latter less so. WWI had cut-off supplies of all synthetic organic chemicals from Germany, the main global supplier. DuPont succeeded in using its research to start producing three it needed to make the vast amounts of explosives for the war in Europe, which the U.S. had yet to enter. While it amassed great profits, the dye and other industries in the U.S. that badly needed the same organic chemicals were left wanting. The serious shortages of dyes, used in many industries, led to leaping prices and an unhappy and vocal public. The government, too, was keen on establishing dye manufacturing in the U.S. Fearing a backlash from the public and the government, DuPont concluded that the risk of not starting dyes and intermediates manufacturing was very high. But it seriously misperceived the full risks of entering, believing it had the needed research and manufacturing capabilities or could build them easily, a big

market existed, and there was almost no competition. Instead, the company would invest the vast sum of \$40 million over 18 years before making a profit from dyes and intermediates.

In the instances described, the risk of inaction was vividly evident, high, and close to certain. Conversely, when DuPont lost the opportunities to enter drugs and fertilizers, described in sub-sections to follow, the risk of inaction or not taking these growth possibilities was not viewed similarly. Instead, decision-makers were more certain of the risks they saw in entering these new businesses. With drugs, they saw high risk in research, manufacturing, and markets. With fertilizers, little risk was seen from not entering but high risk of competition if the company were to enter.

DuPont also did not take promising growth possibilities by expanding explosives sales internationally even though it would have allowed it to balance the four sources of risk and the risk of inaction was very high. After gaining control of the U.S. explosives industry, DuPont began studying expansion into about a dozen foreign markets, including Mexico, Canada, and a few S. American countries. The company already had strong research and manufacturing capabilities and risks in foreign markets was higher but not unduly so. The proximate Canadian market was similar to the U.S and was entered in 1910. In the remaining locations, DuPont saw the risk of competition as very high. An earlier agreement with the Nobel Co. and other European explosives companies had divided the world into four regions. DuPont had the U.S. market for itself and Nobel and the Europeans had Europe. The remaining regions were open to all parties to the agreement. Especially after the 1907 antitrust lawsuit and the threat of having a large portion of its production capacity idle, expanding abroad provided a quick new avenue to growth. But DuPont concluded that Nobel and the Europeans were already well-entrenched in S. America and it was averse to competing with *them*. They were often referred to as ‘our European friends’. The companies frequently shared information and technologies for use in their respective home markets where the others did not compete. Although the agreement did not preclude DuPont from competing – it would not have explored the possibility if it had – the company was unwilling to compete with its ‘friends’ despite its desire to grow and pressures to diversify. More than the risk of actual market-based competition, it saw the loss of its friendly, cooperative ties as being higher than any profits

forgone from international sales. Later, during the war years, it again considered entering China, Russia, and Chile after the war but only in collaboration with Nobel. No such collaborations resulted.

3.2.2 Narrow vs. broad links. With DuPont's interest in growth through new business, riskier possibilities reflecting new directions were more likely to be pursued if they were seen to be linked with existing or future businesses. Explorations related to nitrocellulose, dyes, and other search domains during the war years were examples of such links. Links can help manage and reduce perceived risk from the four sources in new domains. Broad links suggest lower risk than narrow links between a growth possibility being considered and existing and future businesses. The same possibility, if viewed in isolation, would appear far less attractive. Beliefs regarding links often proved inaccurate but they nevertheless influenced exploration-exploitation choices. Continued explorations sometimes revealed that the links were not as strong as initially thought, so some domains were abandoned. Explorations in others continued despite losses because important links were seen to exist.

Upon discovering that no business would utilize idle explosives plant capacity after the war, search shifted to new businesses that would utilize the organization – plants, infrastructure, employees, and scientific and manufacturing knowledge and capabilities. These subsequent searches were framed broadly, as having important inter-linkages such that they would enable entry from one to another. Drawing upon the successful experience of German companies (Beer 1959), a manager argued, “There is a natural connection between explosives and dyes.” The connection was of skills and knowledge of organic chemistry and production processes. And among the industries seen to benefit from knowledge and expertise in dyestuffs and organic chemistry were mining, plastics, rubber, insecticides, herbicides, explosives, pharmaceuticals, lubricants, refrigerants, detergents, perfumes, flavorings, paints, varnishes, lacquers, printing ink, and photographic materials. The exact nature of these links was not known to DuPont – that would require research and experimentation. But entry into dyes and intermediates was hoped to later pave the way into other “allied” new businesses. The Executive Committee agreed that the “extent and scope of the dye manufacturing business seems almost limitless” and in 1917 DuPont entered

dyes and intermediates. Besides influencing entry, this broad framing later influenced the company's decision to persevere despite its struggles to succeed and incurring massive losses for 18 years.

The risks in dyes research, manufacturing, and competition emerged to be far greater than DuPont had anticipated. Lacking the needed knowledge and expertise, it began intensive research but soon discovered that its scientific talents were inadequate for the task. Suitably qualified chemists could not be found. It tried acquiring know-how from England, as Germany, the leading global dyestuffs supplier and repository of knowledge and expertise, was cut-off due to the war. DuPont's attempt to buy an English dye manufacturer failed. The British Government would not permit it, wanting to maintain dye manufacturing in England. DuPont then bought information from a dye company there and sent its engineers and technicians over to train. They also toured a German dye plant in England that had been seized by the government. But the DuPont employees had to return hurriedly because Germany was threatening to sink neutral ships leaving British ports. In 1918, the U.S. Government seized the U.S. assets and patents of German companies. DuPont licensed those in dyes and pharmaceuticals, as did many others. But it found that dye patents lacked information crucial for manufacturing. There was little information on equipment and processes, and a dye could not be traced back to specific patents. Dye composition was known only roughly or completely unknown. Explained a chemist, "The truth is that it takes nearly as much effort to decipher the correlation between patent and commercial dye as it does to discover the color originally, and this has been the chief cause of the delay in making the newer dyes." Intermediates were frequently unavailable. And slight variations in processes could yield an entirely different product. DuPont's first batch of indigo was yellowish-green. An Executive Committee member with experience in the dyestuffs venture reflected, "No manufacturing in the world is more difficult technically, more dependent on the highest skill, the minutest study, the greatest experience; and to a very limited extent only was this knowledge and experience available in America prior to the war." Links to facilitate a smooth transition from explosives to dyes proved tenuous rather than strong, as initially hoped.

Exacerbating these risks were those of competition which proved to be very high. German imports restarted after the war ended in November 1918. Even though demand was high, the very high

prices of the war years now dropped just as steeply. Meanwhile DuPont had to continue making large and sustained investments in research, manufacturing, and marketing. As it continued to struggle and the competitive environment worsened, DuPont considered exiting dyes in 1920. It persevered, however, believing that the chemical capabilities it was building would later enable entry into other new businesses.

When entering dyes and intermediates, DuPont had estimated an expenditure of \$7 million to operate successfully. In the next 5 years, it spent 3 times that amount. It would take \$40 million and 18 years to make a profit. Upon finally achieving success, Charles M. A. Stine, head of the Organic Division during the war and later a member of the Executive Committee observed, “Without an unwavering faith in research, the organic chemical industry [in the U.S.] would not exist today. A clear vision of the possibilities of such an industry was also essential, and likewise ‘patient money’ ... I cannot speak for the entire industry, but I do know that during the early years when the DuPont Company was conducting intensive work with dyestuffs and other organic chemicals, an outlay of more than \$40 million was made without one cent of profit being realized. This outlay represented plant investments, operating losses, and research expenditures. I am sure our experience was not unique.”

Yet, DuPont had viewed acquisition prices of \$1.5 million for celluloid in 1914 and \$5.188 million in 1918 for drugs as being too excessive for entering those businesses. Had it been able to assess the risks, time, and costs of research, manufacturing, and competition in dyes more accurately, it might plausibly have made a different choice. It had concluded early that dyes and intermediates would not utilize post-war excess capacity, taking away the initial reason for wanting to enter the business. Soon, it also realized that it lacked essential expertise and many required raw materials were scarce or unavailable. Instead of starting dye manufacture, DuPont could have sold the organic chemicals it made, the ones it feared being accused of profiting from during WWI while other businesses were starved of them, to others in the dye business to offset any immediate threat of the public’s and government’s backlash. In July 1915, it did seriously consider making intermediates and selling them to dye manufacturers. It had even been approached by the latter with exactly that request. Selling essential ingredients to others was an option it had also seriously considered earlier and found agreeable when seeking outlets for its

nitrocellulose-making idle capacity. Alternatively, it could have entered dyes less ambitiously and instead reallocated some of its war profits to entering drugs where it could have succeeded rapidly.

Explorations regarding the drugs business were part of the synthetic organic chemicals search domain. Just as explosives and dyes were believed to be related in their use of intermediate chemicals and manufacturing processes, so were dyes and drugs (Beer 1959). Belief in these links, however, did not ensure smooth passage from one to the other. Upon initial exploration the Development Department expressed reservations in 1915 about entering drugs, “We are inclined to think the manufacture of compounds used as drugs would be a little too much of a step in the present state of our development [in] the chemical industry. Refinements have to be used in order to get the drugs in a pure condition and our ordinary methods of working would not be applicable.” But it identified acetphenetidin, an analgesic used to reduce fever and pain, to be researched and possibly produced. Although its demand used to be “rather irregular”, its price had risen due to war shortages. As exploration increased in 1916, an Experimental Station scientist, who happened to have 10 years’ experience working for drug companies, prepared a list of 515 pharmaceutical chemicals he was familiar with for Du Pont to consider manufacturing. The company, however, decided to enter dyes and intermediates, not pharmaceuticals. Although the industry was seen as very profitable, some at DuPont believed that demand would rise only slowly and would be affected by factors such as legislation and “attitude of physicians” that could not be controlled by drug companies. Beliefs regarding the industry’s promise varied within DuPont and interest remained. In 1917, it tried buying the Schaefer Alkaloid Co. for its “information, secret processes, patents, etc.” to enable quick entry but the two could not agree on a price.

3.2.3 Long vs. brief time frames. Whether growth possibilities were assessed using a narrow or broad time frame influenced exploration-exploitation choices.

DuPont lost a promising opportunity when it decided against entering the young and growing fertilizer industry. In 1910, while studying nitrocellulose-based businesses as new growth avenues, it also began exploring the possibility of selling nitrate of soda, an explosives ingredient, to farmers for use as fertilizer. Compared to Europe, U.S. fertilizer adoption was small but rising steadily. The market was

seen as having “enormous” potential and DuPont concluded that selling soda as fertilizer would be “a handsome business”. The company was the largest U.S. consumer and importer of soda from Chile, the sole global source for it. It also owned soda properties in Chile and had long had the infrastructure to purchase and ship it from there to the U.S. Within the U.S., it had a wide distribution network and sales force for explosives that it believed could be used to also sell fertilizers. The idea was not unreasonable – Ford would later sell a by-product from its coke ovens as fertilizer at its car dealerships. Higher soda sales would lower DuPont’s cost per ton and Chilean suppliers were keen to provide subsidies to expand soda’s use in explosives and fertilizers. Previously, DuPont had been wary of risking the enmity of the fertilizer interests but by 1910 it no longer saw this as a risk. The government had previously filed an antitrust lawsuit against the fertilizer interests, although it was later withdrawn. Moreover, the market potential was vast and DuPont felt that distribution locations could be selected to boost demand and ensure that everybody profited. It was also willing to sell potash and phosphate, complementary products it was familiar with, to more fully meet farmers’ needs.

But DuPont did not enter the fertilizer business. Instead, it entered artificial leather and expanded the explosives business into Canada. Although the antitrust lawsuit against it was pending, the government had again begun placing explosives orders, taking off some of the pressure to diversify. Upon losing the antitrust lawsuit in 1911, having its explosives business broken into three in 1912, and suffering a decline in explosives sales in 1913 and the first half of 1914, the company still did not move into fertilizers by redirecting its supply of nitrate of soda from explosives. With steady growth and 1913 sales of \$170 million, the fertilizer industry was now being called one of the largest and most important in the U.S. DuPont, however, concluded that the industry was “almost universally unprofitable” and most sellers just broke even. Its conclusion was based mainly on 1910 and 1911 data when the industry was in a cyclical downturn. The industry comprised hundreds of small sellers but three large companies made the majority of sales. With economies of scale, the many small sellers were unprofitable, especially during a downturn, but that was not so with big sellers comparable to DuPont. The latter group had seen earnings decline during the downturn but had not suffered losses. In looking at a narrow time frame,

weighting recent profit data heavily, and looking at profits of firms of all sizes and not just of comparable ones, DuPont reached an erroneous conclusion about its profit prospects.

Fertilizer sales were concentrated in the South. DuPont's wide distribution network would have allowed it to emphasize markets in the Northeast, Midwest, and West where fertilizer use was lower but markets had room to grow, a process it could have facilitated. It failed to consider how its economies of scale, control over supply, distribution network, and research capabilities could change industry structure in its favor, and omitted to link the cost-benefits to explosives of being in fertilizers. The U.S. fertilizer business was not driven by research but it was being conducted in Europe. DuPont's long-ongoing research on nitrogen fixation was viewed by some at the company as potentially benefiting fertilizers more than explosives, the original reason for initiating the research. And the American Cyanamid Company had successfully used nitrogen fixation research to improve the quality of its ammonium phosphate fertilizer. DuPont could have undertaken research itself. It was intimately familiar with nitrate of soda and potash, and was among the leaders in the U.S. for using research for invention-driven growth (Hounshell and Smith 1988). Even in a new industry, artificial leather, it had succeeded in inventing a product that was a major advance in quality over those sold by longer-established companies.

By August 1914, concerns of finding alternate uses for idle capacity and raw materials evaporated when DuPont was deluged with explosives orders from Europe for WWI. It now needed all the nitrate of soda for itself to meet the massive and rapidly rising demand. When the war ended in November 1918, explosives demand plunged along with DuPont's need for nitrate of soda. The fertilizer industry was now in an upswing, demand had risen steadily in the intervening years, and comparably-sized players remained profitable. The time was again opportune for DuPont to redirect nitrate of soda into fertilizers, invest its remaining war profits, and exploit its greatly improved research capabilities for this business. But the decision to not enter made early in the decade was not revisited.

Conversely, in taking a longer time frame for the dyes business resulted in DuPont remaining in it despite continuing losses and difficulties in developing needed capabilities. It additionally believed that

success in the dyes business, long though it may be in coming, would build capabilities that would later pave the way for entry into various other chemical businesses.

3.3 Power-Based Influence. When the preferences of powerful individuals were at variance with the work being pursued in the organization, they were more likely to exert their power, based on formal hierarchical position and ownership (Finkelstein 1992), to influence exploration-exploitation moves that would otherwise not have been made, resulting in both opportunities being taken and lost. The use of power was, however, not frequent; only when the deviation in preferences was large. High ambiguity and uncertainty created occasions for the exercise of power because different interpretations of any situation were possible along with beliefs regarding suitable action.

Artificial wool and extracting grease from sewage were explored entirely at the urging of Irénée du Pont, a senior manager, stockholder, and member of the du Pont family. Both explorations were short-lived, yielding nothing of value. The many ongoing explorations in early 1917 included the study of manufacturing oils and grease. Irénée suggested that since sewage contained a considerable amount of grease, why not develop a method to extract it? The Chemical Department scientists doubted it could be done or a profitable business created but agreed to conduct studies. Similar ideas from people outside the company were routinely dismissed. Nothing emerged from the studies. The following year, Irénée asked them to research the possibility of a fiber that could be used as a substitute for wool. It was a reasonable idea because artificial silk existed and was being studied by DuPont. Little progress emerged with the lapse of a few months. The subject had proved difficult and the scientists were occupied with many other studies. Based on recent market data, they also expressed skepticism that artificial wool would sell well. Irénée offered ideas for new studies and argued that for a good quality product, the market would be big. Artificial wool was worth pursuing, he reiterated. The Chemical Department agreed. They were hesitating due to war-related work, but a reasonably priced wool substitute would have “very great possibilities”. After a while they reported back that their studies had not made any headway. Irénée responded that they could use their judgment regarding the idea to find a substitute for wool but if they did not think the idea was worthwhile, they should let him know so he could pass on his suggestion to

someone else. The Chemical Department replied it was starting work on the development of a wool substitute. Nothing of significance emerged from the research on wool substitutes.

Far more material were the company's exploitation choices to enter celluloid and motor cars and not enter the drugs business, as a consequence of power-based influence.

No exploration preceded DuPont's entry into motor cars. The move was made strictly at the urging of Pierre du Pont and his trusted company treasurer and Executive Committee member, John R. Raskob. The two had been investing personally in General Motors Corporation (GM) shares since 1914 and insisted that DuPont's war profits be also invested in the shares. Both believed in the high growth potential of GM and the young motor car industry, and expected to profit well from GM's rising share price. GM would also be a customer for DuPont's artificial leather, paints and varnishes, celluloid plastics, and rubber-coated fabrics, it was subsequently argued. From 1917-1919, DuPont purchased a third of GM's stock and Pierre became its president. Were it not for the insistence of the influential duo, this new growth possibility would not even have been considered; it was so far removed from DuPont's capabilities and businesses. There were no studies and considerations preceding the duo's suggestion to enter the industry. On earlier occasions, in turning down some proposals, the Executive Committee had expressed its view that anything "mechanical" was far removed from DuPont's capabilities and interests. Unlike entry into all other search domains, there were no considerations of balancing the four sources of risks associated with exploration-exploitation. GM was run separately from DuPont. The entry, however, led to explorations that would otherwise not have been undertaken. DuPont tried unsuccessfully getting into auto plant constructions to avoid laying off the large number of employees it had hired in the war years to construct explosives plants. And it got into researching motor fuels, an idea it had only recently rejected for being too far removed from its interests. But two days after the war ended, Irénée led the efforts to have DuPont do research for GM on motor fuels. The latter was unenthusiastic and unsupportive. DuPont persevered but its research yielded nothing useful. In 1922, DuPont entered the tetraethyl lead business to exploit a discovery made in GM's labs.

Explorations regarding the plastic celluloid began in 1909 as part of the larger search to find nitrocellulose-based businesses to utilize DuPont's idle capacity of smokeless powder plants. To better understand this unfamiliar business, the Development Department conducted thorough studies of trade conditions, prices, costs, and manufacturing. Competition was seen as "keen" due to the presence of four large celluloid manufacturers. DuPont lacked manufacturing knowledge and was unsuccessful in getting the know-how from Germany. Search declined as the U.S. Government renewed its explosives orders in early 1910, taking away the pressure to find new nitrocellulose-based businesses. Meanwhile, DuPont entered artificial leathers and expanded its explosives business in Canada. Celluloid search rose again in 1913 as the explosives business slowed down, the economy went into a recession, and worries of idle capacity resurfaced. DuPont again tried acquiring celluloid manufacturing know-how from a German expert, studied a joint venture in the U.S. with him, sent a manager to Germany for plant visits to learn about manufacturing, considered getting a process from the Nobel Co. in Norway, and studied manufacturing of Cellon, a new and costly material based on cellulose acetate that was being produced in Germany. DuPont assessed just selling nitrocellulose to celluloid manufacturers, and entering the industry using its own research or with an acquisition. Ruling out the first, it continued exploring the latter two. By April 1914, it was studying what sized plant to construct or to buy the Fiberloid Company, a large manufacturer, for \$1.5 million. It was also advised by an expert to start manufacturing at an existing plant and to not manufacture finished goods in the near term because the needed capabilities would take substantial time and money to develop. The Executive Committee decided to grow the celluloid business internally rather than make an acquisition, feeling it was over-paying and did not have enough information on the candidate. Indications of adverse market conditions and a slowing economy also made any immediate major move unattractive (narrow time frame). An acquisition decision was postponed until some of these uncertainties were resolved. Research on celluloid had already begun at the Experimental Station, which called it a "doubtful subject" while forecasting research expenditures. The Development Department cautioned against haste in getting into the celluloid business. Meanwhile, the start of WWI eased the pressure to find outlets for idle capacity.

Despite booming explosives demand, in December 1914, Pierre expressed his preference for buying control of or purchasing outright one of the larger celluloid manufacturers to enable entry into this “entirely new business”. The recently recomposed Executive Committee agreed but decided against the Fiberloid purchase. Work began on constructing an experimental celluloid plant. In September 1915, the Development Department recommended buying the Arlington Company, another large manufacturer, for the far higher price of \$8 million. After years of exploration, Irénée, Pierre, and two other senior managers finally stated in exasperation to the Executive Committee that they should either make the acquisition or end further deliberations. The acquisition was made in December. DuPont entered the celluloid plastic Pyralin, lacquers, and enamels; all used nitrocellulose. Although the acquisition did not immediately provide a large return, the celluloid entry widened research on plastics. In the decades after 1939, the plastics business would grow greatly and become an important part of the company’s portfolio. Along with the acquisition, the Experimental Station began studying the suitability of titanium oxide, a new white pigment, for use in Pyralin. About fifteen years later, pigments and titanium dioxide would also become big businesses at Du Pont.

DuPont’s interest in the drugs industry remained after its failed 1917 attempt at buying the Schaefer Alkaloid Co. In November 1918, an unusual and timely opportunity arose to buy the German drug company Bayer’s U.S. subsidiary. Under the Trading with the Enemy Act, the U.S. Government had seized the U.S. assets of all German companies and was auctioning them off. Bayer’s assets were to be auctioned on December 3. DuPont accorded the purchase serious study. “It has always been our intention at some time to go into the production of pharmaceuticals,” wrote Lamont du Pont, the younger brother of Pierre and Irénée, and the head of department that included DuPont’s new dyestuffs business.

Bayer used to sell many organic chemicals in dyes, intermediates, and pharmaceuticals and the seized assets included plants and patents. The Development Department conducted a detailed analysis of the value of Bayer’s assets. It concluded that although the dyestuffs plant was large and modern, it had many similarities with DuPont’s, so the company would not acquire much new knowledge in dyestuffs manufacturing. There was some overlap with the intermediates DuPont manufactured or was about to.

Others in the industry also sold a few of the same chemicals. And there was some market uncertainty. With the armistice signed on November 11, it was unclear whether Germany would now be allowed to export dyestuffs to the U.S. and what the tariffs would be. The Development Department calculated that DuPont's dyestuffs business would add about \$1.5 million to sales from the purchase. More vital than the plant were the patents but the Department felt they were almost impossible to value accurately. Bayer owned over a thousand dyestuffs patents covering a large range of classes. DuPont identified 432 as especially important, and most important were 110 patents on anthracene dyes; an area it was keen on entering. Owning these dye patents would confer a significant advantage so it was also very concerned that its competitors not buy them. Bayer also had 56 rubber patents. Although currently unrelated to DuPont's businesses, they were seen as being potentially very useful. Finally, Bayer had a small business manufacturing chemicals that were used in the photography business.

Bayer's pharmaceutical plant afforded DuPont a quick entry into that business. The plant manufactured a number of drugs but Aspirin, which accounted for 90-95% of Bayer's pharmaceutical business, was by far the most important. The company had manufactured, distributed, and marketed Aspirin for years. Du Pont recognized that developing such a business on its own would cost it far more than purchasing it at the auction. It would also get the name and trademark "Bayer" and "Aspirin". Due to the sentiments caused by the war, perhaps it would be wiser to use the name "Du Pont" in the US, concluded the company. "Bayer" could be used in other countries, especially those in S. America. The name "Aspirin" had little value. It was widely known. Moreover, its use was under dispute between Bayer and other manufacturers of that drug. It seemed likely that the courts would give others the rights to the name as well. Pharmaceuticals profits had averaged \$1 million for Bayer since 1913. It also had a small export business that could be grown. Finally, Bayer owned 165 important pharmaceutical patents that could be useful in establishing a strong presence in the industry.

Using various assumptions and "extremely conservative estimates", the Development Department calculated that DuPont's annual profits from utilizing the dyes, intermediates, and drugs assets would be \$620,000. Buying just plant and equipment, not counting a many-year old business that had been very

successful in the last five to six years, would cost much more than \$2 million. Its conservative valuation of all Bayer's assets ranged from \$2,606,045.21 to \$2,829,959.62 and it recommended spending up to \$3.25 million at the auction, a price that would yield DuPont a fair return on its investment. "We do not believe that \$3 million could be expended by us in the dyestuffs department in any way which would show the promise of returns that this expenditure should show by the purchase of these companies," concluded the Development Department. But it cautioned against the "paying of a pride".

Lammot, on the other hand, approached this uncommon opportunity with less caution and no doubt – DuPont had to purchase the Bayer properties. He urged the Executive Committee to spend up to \$5,188,000 at the auction, pointing out that it would very quickly make the company an important player in both dyestuffs and pharmaceuticals. Reflecting on DuPont's ongoing struggles with manufacturing dyes, he argued, "[W]orking up organic chemical processes and products without any starting point is a very slow and laborious procedure." The Bayer properties would provide the needed starting point. Lammot further explained to the Executive Committee, "It is a fact that experience gained in one branch of organic chemistry is frequently of great value and importance in the other branches; in fact many of the processes and materials used in the synthesis of important natural products such as camphor, glycerine, rubber, etc. are the same as those used in the dyestuffs industry." Bayer's assets provided a ready and broad foundation from which to diversify into other organic chemicals and industries. Such breadth was the case with the successful, giant, diversified German chemical companies. A failure to buy Bayer's assets would "reverse" DuPont's plans of diversification and growth, concluded Lammot.

The Executive Committee rejected Lammot's figure of \$5.188 million and approved \$3.5 million for the purchase. It was earlier willing to bid a maximum of \$4,688,000 but lowered that amount, persuaded by the Development Department's analysis and estimates. Lammot had protested even the earlier larger amount, saying that it was "inadequate for the value to be obtained and that we will lose the opportunity to purchase". DuPont lost the bidding by a wide margin. The Sterling Products Co. won with its bid of \$5.31 million. Sterling sold off Bayer's dyes assets and kept the pharmaceutical ones, becoming a major and profitable player in the industry. The modern day U.S. Merck was also built on the

seized U.S. properties of Germany's Merck. DuPont lost a major opportunity to enter the drugs business. There was no dearth of funds for the Bayer purchase, thanks to its vast war profits. Perhaps the timing of the auction, less than a month after the armistice was signed, made DuPont conservative about how to spend its funds, knowing its explosives sales would now drop to pre-war levels. The previous year it had made a big investment in dyes and the business was struggling, and it had entered the paints business that had yet to perform well. DuPont had also been steadily buying GM shares since 1917. It possibly saw continuing that as much less risky and providing better returns than investing in and growing a drugs business. And there was no vivid and pressing risk of not entering the drugs business. Developing expertise in dyes and intermediates was meant to enable entry into other industries such as drugs, a major reason for entering dyes, but entering drugs was not similarly seen to lead to other linked industries.

The Executive Committee, Development Department, and Lamot du Pont perceived the potential of the drugs opportunity differently. Lamot was the most optimistic and entrepreneurial (Palich and Bagby 1995). The Executive Committee displayed the anchoring and adjustment bias (Tversky and Kahneman 1974) but made the adjustments more than once, influenced both by the Development Department's figures and Lamot's. Ultimately, the risk-averse former group had more influence on the Executive Committee than the latter risk-taking individual.

DuPont's interest in pharmaceuticals remained until the end of the 20th century. On many occasions during this period it considered acquiring well-known pharmaceutical companies but was reluctant to pay the price the market commanded, which it saw as excessive. It eventually bought a small player, Endo Laboratories in 1969, began growing its pharmaceuticals business internally in the 1980s, created a joint venture with Merck in the 1990s, and bought out Merck's share of it after a few years. DuPont remained a peripheral player, reluctant to spend what was needed for acquisitions while the industry around it steadily consolidated with M&As and competitors grew rapidly in size. At the turn of the century, DuPont exited the drugs business. The drugs business was a series of missed opportunities where DuPont was unwilling to take needed risk in areas outside research.

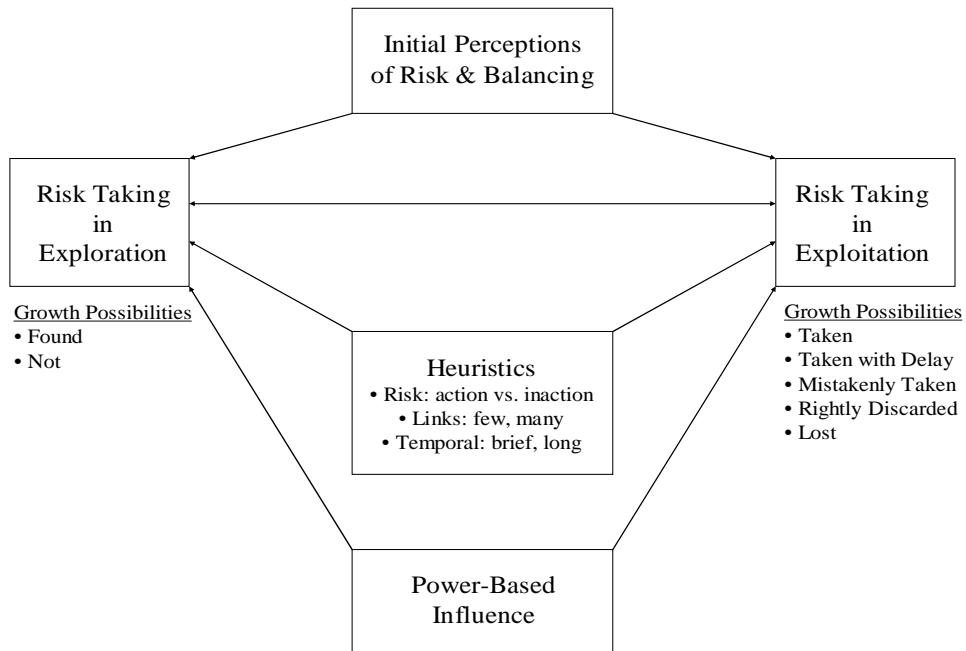
4. Conclusions

Finding the literature lacking in decision-making process explanations of how firms miss growth opportunities, this investigation undertook a field study to develop such theoretical explanations. The case research method was used to analyze comprehensive archival decision-making data on exploration and exploitation over a 20-year period at the DuPont Company, complemented by contemporaneous newspaper articles. Lost opportunities were analyzed using the counterfactual method of business and economic historians. Choices of which new domain to explore were based on attempts to manage risk from various sources. The decision whether to exploit new growth possibilities generated from exploration was influenced by the following heuristics: risk of action vs. inaction, few vs. many links with current and future businesses, and brief vs. long time horizon. When there was a significant deviation between the preferences of powerful individuals and the exploration-exploitation considerations of the organization, they exercised their power to influence choices. These cognitive and power dynamics combined to result in growth possibilities being found, taken, and lost.

Figure 1: Types of exploitation moves regarding growth possibilities

Growth Possibility	Taken	<p>True Positive, Rightly Accepted – Opportunity Taken</p> <ul style="list-style-type: none"> • Consolidating US explosives industry • Fuses • Chilean nitrate of soda • Artificial leather • Explosives in Canada • Artificial leather • Artificial leather in Canada • Artificial silk • Celluloid • Copper shells & blasting caps • Fulminate of mercury • Sawmill & timberland • Rubber-coated fabrics • Cinematographic films • Dyes & intermediates • Cellophane 	<p>Type 1 Error, Wrongly Accepted – Possibility Mistakenly Taken</p> <ul style="list-style-type: none"> • Loaded shells • Auto plant construction • Torpedoes
	Not Taken	<p>Type 2 Error, Wrongly Rejected – Opportunity Lost</p> <ul style="list-style-type: none"> • International explosives sales • Fertilizers • Drugs 	<p>True Negative, Rightly Rejected – Possibility Discarded</p> <ul style="list-style-type: none"> • Explosives plants for foreign governments • Cotton seed from hulls • Pyrites, sulfur • Chile: Railroads, bags • Waterpower • Water distillation • Boat bottom paint • Waterproof caps • Fireworks • Explosives supplies, equipment for others • Potassium in Peru • Machinery & tools • Cartons, tin boxes • Cotton hose lining • Pulp & box factory • Paraffin from waste paper • Biomanufacturing glycerin • Photographic chemicals • Mixed varnishes & paints • Water-soluble inorganic chemicals • Paper, cotton cloth • Investments, banking • Cement • Rifles, cartridges • Artificial wool • Rubber, synthetic rubber • Refining refuse salt • Cattle feed • Copper wire • Hunting magazine • Electric air drill • Quicksilver • Safety fuse, fuse wire • Amyl acetate • Photographic film • Oil cloth • Printing ink • Perfumes, flavorings • Food preservatives • Inorganic chemicals • Vegetable oils, fats • Soap • Nitrogen fixation • Rubber chemicals
		Opportunity Present	Opportunity Absent
Actual Condition			

Figure 2: Corporate entrepreneurial decision-making process model



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