Role of Management Control Systems During Early Years of PARC

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A management control systems perspective is applied to the history behind Xerox PARC's founding and innovative development of technological products. The inability of Xerox to commercialize their many innovations at PARC is traced back to the inception of the ROI financial control metric at DuPont. While the story of PARC in the 1970's has been well-studied from a strategic-management perspective, we believe an accounting management control perspective, framed within management theories, sheds new light and gives richer context to the decision-making processes at Xerox PARC during the late 1960's through the 1970's.

Keywords: Xerox PARC management, management control systems, ROI, return on investment

INTRODUCTION

The design and research achievements of Xerox's Palo Alto Research Center (PARC) during the late 1960s and early 70s has laid the foundation for today's high-speed technological infrastructure. While Xerox is primarily known for introducing the copier to the world, PARC's R&D revolutionized technology with the development of the mouse, the graphical user interface (GUI), the portable computer, the laser printer, a timesharing system, and a distributed net-work system seen as the precursor to todays' Internet (Hiltzik, 2000). Given the array and degree of accomplishments achieved at PARC, one wonders and questions: *How did these technologies not propel Xerox into the forefront of today's preeminent technology companies?* Prior studies have examined this question from a managerial (Wessel, 2012; Smith and Alexander, 1999; Wren, 1994), organizational (Amabile and Kramer, 2011) and strategic (Knot, 2018; Hiltzik, 2000) set of perspectives. We believe these viewpoints only tell a portion of the story. A crucial and overlooked part of PARC's history lies with the management control systems that were employed by Xerox during this time-period.

Organizationally, XEROX created a series of research laboratories for generating innovative ideas and technologies that could serve as the basis for developing new products. PARC founded in 1970 as one of Xerox's research laboratories, was charged with creating and developing new technologies out in California while corporate remained in Stamford, Connecticut. This distance helped foster the innovative atmosphere at PARC, as management did not hinder the every-day creativity achieved at PARC. From a management perspective, this distance allowed the directors of PARC, the freedom to encourage their scientists to pursue projects they championed and were most passionate about. However, the distance also led to confusion

regarding lines of authority and demarcation points surrounding control and decision making (Argyres, 1996). Management theories regarding span-of-control (Van Fleet and Bedian, 1977), core competencies (Leonard-Barton, 1997), distance-power (Daniels and Greguras, 2014), and diffusion of innovation (Van de Ven et al., 2008; Rogers, 2004) have all been utilized to study and explain how Xerox allowed some of the most important technological developments of the last century, slip from their grasp.

PARC's strategic and organizational failures and its contribution to the decline of Xerox have been well documented (Gertner, 2013; Strassman, 2008; Hiltzik, 2000; Smith and Alexander, 1999). The application of management theories has been able to give a degree of context to what happened from a strategic, organizational and managerial set of perspectives. These management and organizational theories have been used to explain the failures of Xerox in their attempts to capture the nascent computer market of the mid-1970s and 1980s. The essential story from these studies points towards the leakage of core competencies out of PARC (Galunic and Rodan, 1998; Conner and Prahalad, 1996) due to poor strategic decision making (Prahalad and Hamel, 1990). However, the basis for these questionable managerial decisions, which led to the unfortunate strategic and organizational outcomes at Xerox, have not been thoroughly examined. We believe the use of management control systems has not been fully considered in prior studies on Xerox PARC. Through an examination of financial documents (i.e. Xerox's annual reports and filings), prior historical accounts and video interviews of former PARC employees (i.e. Strassman, 2008; Hiltzik, 2000; Smith and Alexander, 1999; Shapely, 1993), we trace the roots of Xerox's inability to capitalize on their technological achievements towards strategic and organizational decisions that were centered around management control systems. In the following sections of this paper, we discuss both the key players; from CEO Peter McColough's creation of PARC with Jacob Goldman to Xerox executives Archie McCardell and Jim O'Neill's implementation of management control systems at Xerox; and the critical events that led to the creation and management of PARC. We segue into the impacts that management accounting had on the strategic decision-making process, specifically looking at the historical significance of the return on investment (ROI) metric and trace its historical role in the decision-making process. We conclude the paper with discussions on how the events at Xerox PARC present important lessons that are still keenly relevant in today's technologically-driven business landscape.

THE GENESIS of XEROX PARC

Xerox created and introduced the first proto-type commercial copier in 1959, the *914 Copier*, which helped the company grow annual sales from $61 million ($2.5 million in profits) in 1961 to $1.125 billion ($138 million in profits) by 1968 (Smith & Alexander, 1999). The young executive who was instrumental in the creation and expansion of the distribution/sales channels that helped drive this growth was C. Peter McColough. McColough's early success would lead him to helm Xerox as President of the company in 1966 and eventually CEO by 1968. Upon stepping in as top executive at Xerox, he began to promote and advocate his idea of *"the architecture of information"* based on digital computer technologies. He firmly believed that computers would be the future of business back office functions.

McColough decided that Xerox had to adapt to technological changes that were occurring in the business environment of the 1960s and 70s. He found support for his ideas in Jack Goldman, head of research at Xerox. To deal with challenges from strong new competitors such as IBM and Kodak, Goldman recommended the development of a research center; akin to Bell Labs; that could help drive future businesses for Xerox by developing new digital computer-based technologies. McColough agreed with Goldman's precautions and accepted his recommendation to create a new research center for Xerox. This would eventually lead to the creation of the Palo Alto Research Center (PARC) by Xerox in 1970.

Scientific Data Systems (SDS) and the Palo Alto Research Center (PARC)

The first step McColough took was to acquire Scientific Data Systems (SDS) in 1969. The acquisition of SDS, which cost Xerox around $900 million, was to serve as the backbone of Xerox's new venture into the computing marketplace. In 1970, the year following the acquisition of SDS, McColough approved Jack Goldman's request to establish the best research center with abundant resources. McColough's aspiration

of the "architecture of Information" was to lead the digital communication business via SDS with innovative technological tools which were to be created by Xerox's research and development division at PARC. Accordingly, Goldman began his recruiting efforts for the top-rated researchers in the computing discipline. He first hired George Pake to set up and manage the proposed Xerox research center while he himself remained the chief spokes-person for research and development at the headquarters. The center contemplated by Goldman and Pake was a unit independent of any of Xerox's divisions and the operational processes were to run bottom-up rather than the traditional top-down. The research center was set up at Palo Alto, California to be near Silicon Valley's high-tech companies.

Pake began a national recruiting campaign hiring key scientists such as MIT professor C.R. Licklider; known for his publication regarding complementary relationships between man and computer (Licklider, 1960); and Bob Taylor who promoted the ideas of commercializing time-sharing systems. Eventually, scientists were recruited into three areas of research at PARC: The General Science Laboratory (GSL), the Computer Science Laboratory (CSL) and the Systems Science Laboratory (SSL). GSL was to engage in basic research into computer science with CSL focused on computer hardware and software research while SSL was an extension of CSL focused on developing the computer time-sharing/interactive communication system. PARC became fully operation in 1971 as a research unit of Xerox with Pake as its manager, reporting to Goldman at headquarters.

PARC Administration & Activities

Issues at the Onset

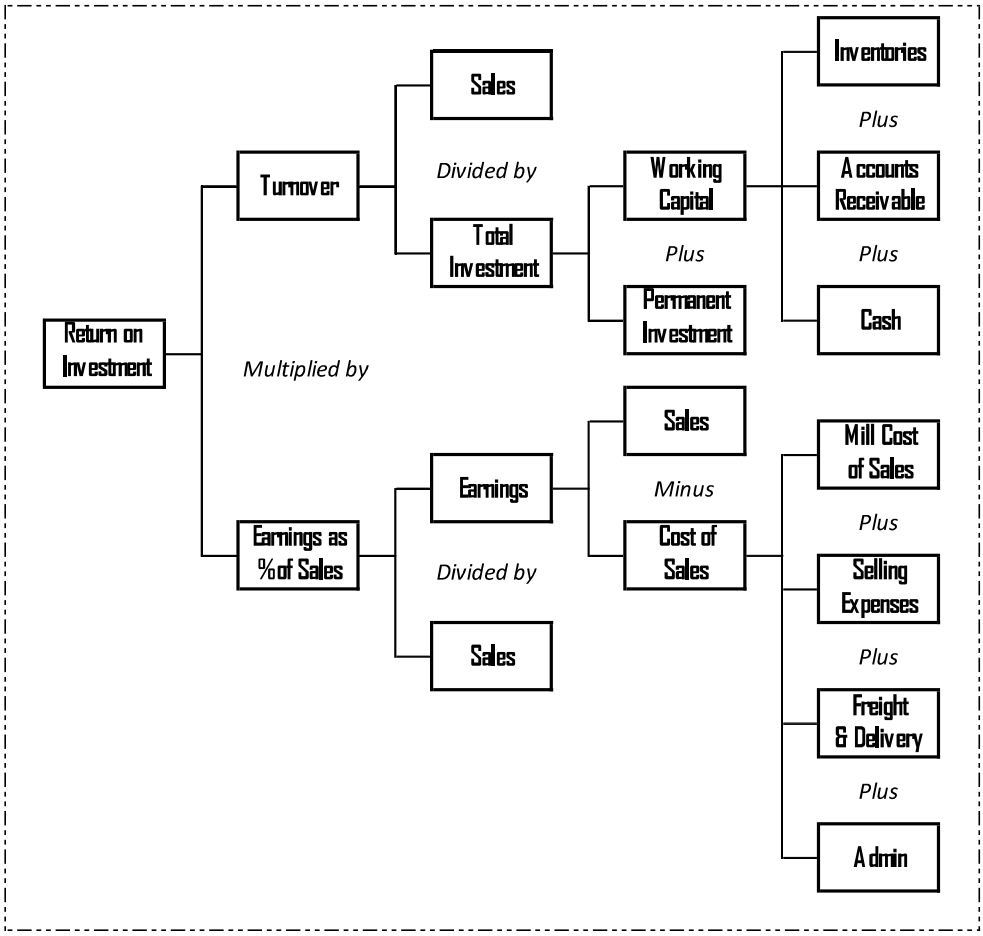
Once established, PARC was to develop technologies that would support McColough's goal of transforming Xerox into a great communication company focused on developing the *"architecture of information"*. This did not go as planned as the CEO of Scientific Data Systems, Max Palvesky, was not interested with the new technologies being developed at PARC (Hiltzik, 1999). His counterpart at PARC, John Pake, perceiving Palvesky's indifference to PARC, was also not interested in making PARC a supporting unit of SDS. A more competitive and acrimonious relationship developed between PARC and SDS, which ran counter to the partnership envisioned by Xerox CEO McColough (Hiltzik, 1999).

With the growing issues between SDS and PARC, Jack Goldman, who had enthusiastically supported McColough on his vision of the future for Xerox, was relegated to an insignificant executive position at Xerox's corporate headquarters in Stamford, Connecticut. This muted his ability to help give voice and advocate for transforming the inventions coming out of Xerox into commercial products. Instead, decisions regarding PARC were falling to Archie McCardell, who became president of Xerox upon McColough's appointment as CEO. McCardell's background as a financial analyst and Treasurer at Ford Motors would be highly influential upon his view on financial and strategic decision making. He was trained in financial reporting techniques of product costing and was a proponent of the ROI control metric which he brought with him from Ford. To give context regarding the importance of the ROI metric that McCardell relied upon for financial control at Xerox, we trace back this key strategic decision-making tool to its initial inception at DuPont.

DuPont and the Development of ROI

It can be argued that one of DuPont's most significant contributions to how businesses approach research and development, was their creation of the *return-on-investment (ROI)* calculation. The use of the ROI metric is now second nature for many organizations, but its initial inception was as a tool for firms to value ongoing and future lines of business (Johnson and Kaplan, 1991). As stated by Alfred Chandler in his historical account of managerial innovations, *The Visible Hand*, "ROI allowed for the first time the integration of financial accounting, capital accounting and management" (Chandler, 1977). The development of the ROI calculation has been attributed to F. Donaldson Brown, an executive in DuPont's Treasurer's Office when the ideas behind ROI were first introduced (Flesher and Previts, 2013).

FIGURE 1
DUPONT'S HISTORICAL ROI FORMULA



The concept of the ROI formulation was DuPont's approach towards the strategic question: ***How does a firm best deploy research and development resources?*** This is closely intertwined with the follow-up issue of: ***How should a firm allocate resources between the short and long term*?** These are not simple questions to answer as long-term investments, unlike short-term R&D expenditures, come with both longer time horizons and higher degrees of uncertainty. While riskier in nature, long-term R&D investments are crucial for a firm's continued survival as only investing on a short-term basis can lead to Schumpeter's warning of "perennial gales of creative destruction-technological obsolescence and market displacement" (Schumpeter, 2008). The development of ROI by DuPont was a means to help address these important strategic questions.

The introduction of the ROI metric at DuPont mirrored a time of diversification at DuPont. The firm was one of the early pioneers of the M-Form (multi-divisional) corporate structure as it began to move away from a U-Form (uniform) structure around 1921 (Chandler, 1962). DuPont was implementing a diversification strategy that would eventually transform it from an explosives-manufacturer towards the diversified chemical giant that it would eventually become. Brown's ROI methodology was instrumental in helping DuPont executives measure and make important strategic decisions regarding existing and new lines of business (see figure 1).

Figure 1, which is adapted from Johnson and Kaplan's *Relevance Lost*, shows how ROI was calculated by Dupont back in the early 1900's (Johnson and Kaplan, 1991). What stands out is that the ROI calculation was much more complex than current ROI techniques. A key part of the DuPont ROI analysis is a solid

understanding of the various lines of business being measured and evaluated. The managers and executives at DuPont, clearly had a strong grasp of the product lines they were measuring and evaluating (Johnson and Kaplan, 1991). While the calculated numbers provided an initial financial basis for making investment decisions, it was the knowledgeability possessed by the executive decision-makers that helped inform the strategic decisions at DuPont. Numbers could provide good support on one hand, but they require knowledgeable interpretation on the other hand.

DuPont Develops Nylon by Following ROI

The story behind the development of Nylon is a classic DuPont example of how effective integration and decision making at DuPont could create such a product. The creation of Nylon was a nine-year development cycle at DuPont, ranging from the start of the project in 1930 to its exhibition at the World's Fair in 1939. The product initiated out of a new organizational structure at Dupont. Several small research teams in the chemical department were given the greenlight to develop new "pioneering research" in chemistry. These teams would find a variety of new polymers but once these new polymers were discovered, the teams were told to shift their focus towards practical applications for the polymers. Polymer 6-6 was eventually developed in 1935, which would serve as the basis for the development of nylon (Ndiaye and Forster, 2007).

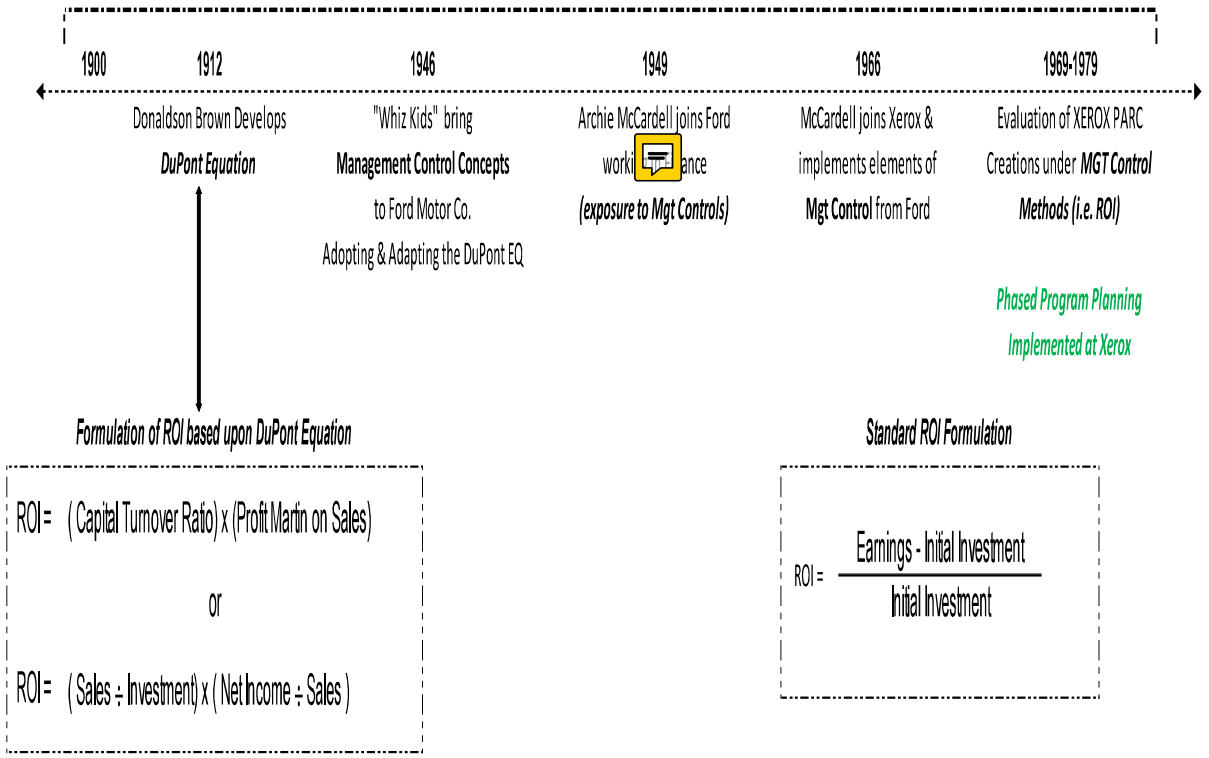
It is important to note that ROI was utilized to help measure the investments being made into these research teams within the chemical department. These investments into the various polymers being developed were viewed as long-term investments for the future of the firm. While ROI was being used to measure these departments and divisions, it was never used as a metric for the evaluation of managerial performance. The top executives at DuPont had an understanding that using ROI to evaluate personal performance would be counter to the long-term goals of the firm and would invite gaming for short-term goals and perspectives (Ndiaye and Forster, 2007). The ability to bring together the combined efforts of three different departments at Dupont (the Department of Chemical Research, the Ammonia Department, and the Department of Rayon) and be given the leeway for a nine-year development cycle was only possible due to the long-term mindset of the executives at DuPont. If a long-term perspective on ROI was not promoted and recognized at Dupont, the development of nylon and its eventual commercial markets might have been attributed to another rival firm.

The Use of ROI at XEROX

Brown's development of the DuPont Equation (Johnson and Kaplan, 1991) in 1912 was primarily done as a financial control tool to help DuPont consider the strategic use and deployment of their assets. It was only one of a series of tools that was used by DuPont and was not viewed as a single-point decision-metric. As seen in Figure 1, the ROI formula that is derived from the DuPont equation is a complex calculation that was created specifically for the lines of business being pursued at DuPont (Johnson and Kaplan, 1991). As other firms borrowed the ROI equation, variations of ROI evolved which eventually led to the current view of ROI that is commonly utilized today (see Figure 2).

The creation of the DuPont formula helped usher in a period of management control-by-numbers in American business though the original intention of the creation was not to use the metric as a single financial control to measure division performance (Dearden, 1969). This approach was epitomized by firms such as Ford Motor Company during the 1940's and 1950's. Ford's struggles during the 1940's led them to hire a group of statisticians known as the 'Whiz-Kids' from the U.S. military in 1946. A key member of this group was Robert McNamara who would eventually become head of Ford Motor Company. McNamara was instrumental in creating a system of management control through financial and accounting methods at Ford. He helped lead Ford's turn-around from its financial difficulties by institutionalizing strong financial controls. Under McNamara, Ford became a corporate example of how effective management control systems could be effectively employed (Shapley, 1993).

FIGURE 2
TRACING THE ROI TIME-LINE FROM DUPONT TO XEROX



It was during 1949 that Archie McCardell would arrive at Ford as a financial analyst, trained in this system of financial control. McCardell's successful career at Ford eventually landed him the position of Treasurer under McNamara. With his successful rise at Ford, McCardell would join Xerox in 1966 as Group President for Corporate services. He brought with him elements of Ford's management control system which he employed and eventually institutionalized at Xerox under the *phased program planning* approach (Strassman, 2008). Figure 2 traces the migration of the ROI concept from its creation at DuPont to adoption at Ford to the implementation of McCardell and O'Neill's planning system. This approach would serve as a key control tool for the strategic decision-making processes at Xerox during McCardell's tenure.

Though the ROI concept was widely adopted by U.S. decentralized companies since the 1920s as a major control tool, Dearden (1969) notes serious limitations which could result in incorrect evaluations of corporate investments. First, ROI control system inhibits goal congruity between the divisions and the entire company. For a division to accept a project to invest, the project has to earn a return at least as high as the division's ROI objective, even though some rejected lower ROI projects could enhance the overall interests of the company. Second, the financial reporting requirement for periodic financial statement preparation and the accounting techniques for product cost determination have added problems to the implementation of ROI as a single ratio for correct division financial control and performance evaluation. Xerox management relied heavily on accounting measurements such as profits to measure return on investment. A management by number philosophy appears to have been very influential on strategic decision making during the 1970s at Xerox. Management decisions were based on costs, market shares and profits with little room for qualitative considerations, such as needs and values of customers. Profit is determined by how product costs are measured and how the market share can be expected to grow based on product costs. Profit measure reflects how the market accepts a product and what prices a firm has to pay for production factors – this is the market control hypothesis (MacIntosh and MacLean, 2014). The cost measure under

the market control hypothesis is the full cost based on the generally accepted accounting principles (GAAP) which includes both variable and fixed production and capacity costs. Full cost is required for periodic income determination for financial reporting purposes under GAAP, but this approach does not serve well for decision making on launching a new product as illustrated in many accounting textbooks (e.g., Jiambalvo, 2016; Garrison, Noreen and Brewer, 2015; Horngren, Datar and Foster, 2015). The required full cost measure for financial statements includes a share of the fixed production costs which do not flow through to the income statement until the sale of the units. Under this concept, the fixed production costs may be mistakenly viewed as variable and incremental with respect to the units sold, but they are not. The reliance on the full cost measure tends to obscure individual product costs and create the problem of cost cross-subsidization among product lines in an environment of complex manufacturing processes. The full cost measure intended for the short-term, periodic profit calculation for external financial reporting statements may lead the management to make inappropriate pricing decisions or wrong strategic decisions to drop a profitable product line. Likewise, if new ventures into the laser printer and personal computer markets were to be undertaken, these projects had to provide a favorable prospect of profit above the full cost and meet the decentralized operating unit's return on investment objective. The original intent of ROI management accounting innovation pioneered by DuPont was to provide an overall performance measure of each decentralized operating unit while considering the overall benefits to the company. ROI was intended to facilitate internal capital allocations and managerial decision making. It was never intended to be used as a single, standalone ratio to motivate division level investment at the expense of the overall company's goals.

The reliance on full cost for management decision making and the short-term focus on profitability have both impacted the ROI control mechanism to potentially ignore key considerations such as being the first mover, being the first to create a new market, and being the first to introduce a new innovative product. There was little incentive for management to push ahead and explore the financial feasibility and potential markets that could be created with the myriad of innovations developed at PARC. As stated by Bob Potter, one of McCardell and O'Neill's managers in charge of product development at Xerox:

> **We were trying to drive cost down and get a minimum product out. We were in the word processing business, not the personal computer business. So, we couldn't very well fund something unless it was consistent with our business charter and made sense in a drive for profitability.** (Smith and Alexander, 1999)

This is in direct contrast to the original intentions of ROI as an initial measure of financial performance (Johnson and Kaplan, 1991). The executives who created and utilized the ROI concept at DuPont understood this and typically balanced out the ROI metric with a longer-term perspective for strategic decision making. Accounts of management's understanding of PARC's innovations and their commercial potential would seem to indicate a lack of knowledge or even interest.

> **Archie (McCardell) is a very, very, extremely bright individual. But he managed by the numbers. Archie would just confer with Peter (McColough) and a decision would be made. It was not well understood why the company was doing what it was doing-whether good or bad, or indifferent. And the lack of understanding went to all levels.** *(*quoted from Xerox insider regarding decision making on PARC from *Smith and Alexander, 1999)*

ROI's Impact on PARC Management

Isolation and Distance

Management research has shown that distance and space will play a key role in the direction and support that individuals, departments, and divisions will receive from top management (Bratic and Warren, 2001; Lam, 1997; Mitsch, 1992). By most accounts, PARC was left alone to create, which was conducive for creativity and research (Nicholson, 1998 & 1994, Gwynne, 1998), but detrimental to winning top

management support for its developments (Hiltzik, 2000; Cringley, 1992, Smith and Alexander, 1999). This distance was also detrimental toward maintaining the support of the innovation champion, McColough, under conditions of isolation or extreme distance (Van de Ven et al., 2008; Rogers, 1995). While the initiation/gestation and creation steps in the innovation process flourished at PARC, the lack of a clear champion for these innovations truncated the innovation journey at PARC. In the case of Xerox PARC, the champion (CEO McColough) abandoned the cause and seemed to lack strategic direction and commitment to change when tested under fire (Smith and Alexander, 1999).

The key decisions regarding PARC would eventually become dictated by Archie McCardell, appointed as President of Xerox in 1968, and engineering and production head James O'Neill. The distance issues between PARC and corporate led to an antagonistic relationship that was further aggravated by numbers. Without gaining any support from top management for its innovations, the costs at PARC were viewed as a pure financial burden for Xerox by both men. The costs incurred at PARC were seen as "additional" costs that were reducing divisional profits and negatively impacting the division's bottom line. PARC was viewed as an impediment for the division's ROI objective. McCardell and O'Neill, who were both financially trained at Ford, borrowed from their prior experiences at Ford to ground financial and strategic decision making with a focus on numbers:

> **McCardell's numbers sometimes blurred instead of clarified his judgement. For example, several former Xerox officials attribute the damaging 1972 decision to combine the copier and computer divisions to McCardell's apprehensions about financial reporting requirements. By consolidating its two operating divisions, Xerox avoided having to report SDS's poor results…That made the company look better but deprived SDS of a general manager…which hastened the deterioration of Xerox's billion-dollar investment.** (Smith and Alexander, 1999)

The unfortunate wall of isolationism that was evident between Xerox corporate and Xerox PARC, not only prevented PARC from advancing their discoveries into commercial usage, but it also blinded corporate to the potential that was displayed before them at PARC (Strassman, 2008; Hiltzik, 2000; Cringley, 1992).

Core Rigidities & Core Competencies

The concept of core rigidities (Leonard-Barton, 1992) can be used to help explain how Xerox executives were blinded to the potential products at PARC. While a firm can develop core capabilities, in the case of Xerox, its copier technology, it will also tend to develop a set of core rigidities. These core rigidities are built through the same activities as core capabilities. A paradox arises since a firm's strengths can also simultaneously become its weaknesses. Taking risks outside of the core competencies becomes difficult for such firms as more conservative decision making is intended to reinforce the core strengths of a firm.

An example of this issue at Xerox can be seen in how they approached the development of Xerox's first word processor during the early 1970s. With word processing products of the time based on conventional nonprogrammable electromechanical technologies, Xerox could stick with this limited technology, which they understood well, or they could move towards a programmable computer utilizing technology developed at PARC. The researchers at PARC pointed to the limitations of electromechanical word processors in dealing with complex editing, formatting, and communications which would not exist within a computerized system. In the end, Bob Potter, the executive in charge of developing the word processing market for Xerox, chose to go with the electromagnetic technology. Potter's decision came about due to two issues. First, McCardell and O'Neill implemented the *phased programming* methodology which expected Potter to market products in one year, not five or ten years. Staying with the well-understood electromechanical technology was more financially feasible and could meet the financial hurdles required by O'Neill. Secondly, after meeting Potter to discuss the decision regarding the electromechanical technology for the word processor, Jim Mitchell a Xerox Fellow at PARC describes the meeting:

> **We said, you don't have the faintest idea this is not going to work. This [electromagnetic] technology is useless…He knew nothing about computers and he wanted to know nothing about them.**

Bob Potter essentially went with the more financially expedient choice at that moment and had little to no understanding of the new technology option that was being presented before him.

Xerox's word processing endeavor illustrates the inability to innovate, primarily due to internal systems being unable to change even when the need to change is recognized from within. This tends to lead to limited experimentation, as new options are only extensions of existing well-worn paths. As a result, a bias to screen out new knowledge will occur as only information on existing technology utilized within the firm is examined. Companies who fall prey to insularity tend to do so from the successes that occur when they develop their core capabilities. Core rigidities begin to take root and make change a very difficult task to accomplish (Leonard-Barton, 1992).

Even when strong potential for the personal computing market was presented before the top management, their biases towards older technologies blinded the key decision makers to the new and innovative discoveries that were laid out before them. This was further reinforced by the *phased program planning* system O'Neill imported from his experiences at Ford (Strassman, 2008). With *phased program planning,* financial hurdles needed to be met before projects could be considered viable. Discussing O'Neill's management style, Jack Crowley a former Xerox executive Vice-President, stated:

> **O'Neill's management theory was one of controls. His theory of controls came out of his experience at Ford. He really believed that if you sat on something hard enough and long enough, you could control the outcome.**

O'Neill's financial background and experiences, a belief in management by numbers, and concern for control made him virtually intolerant of risk - a perspective fundamentally opposed to novel innovation (Smith and Alexander, 1999). As an example, when Xerox was weighing the decision to build a factory in Dallas vs California, for developing technologies coming out of PARC, O'Neill decided upon the Dallas site based upon labor, transportation, taxes, and other cost considerations. While costs tell one-half of any commercial proposition, "the other half – value delivered to customers – did not inform O'Neill's calculations, implying a frozen view of digital technology…biennial leaps in integrated circuitry was a well-established cycle in 1973 and promised to continue" (Smith and Alexander, 1999). In order to capitalize on these rapid cycle changes, the combined skills of engineering, and entrepreneurial developers were needed to act cohesively in an agile manner. Placing the engineering and manufacturing site in Dallas, away from PARC, eventually created a culture that was orthogonal to the technology culture rapidly evolving in California. While Goldman challenged O'Neill's decision, O'Neill had little financial incentive to reverse course. A decision to build in California, while costlier in the short-term, could have potentially brought the discoveries at PARC to market in a more cohesive and agile manner. Numbers and management control systems, championed by McCardell and O'Neill, were the key to the decision-making process at Xerox. As stated by Bob Potter, the manager tapped by both McCardell and O'Neill to develop products for the rapidly expanding word processing market of the time:

> **So, we couldn't very well fund something unless it was consistent with our business charter and made sense in a drive for profitability. I had to get through O'Neill and his financial ratios, to stand the test of return on investment, and of marketing and business plans. Not just gut feel. The pressure on me was to make money.**

The management by number philosophy has led to the problem of the short-run profitability measure focus driven by financial reporting requirements and blind management towards the potential longer-term strategies that could have been implemented (Kaplan and Norton, 1996; Dearden, 1969). Consequently, profits and ROI measures, based on full cost techniques required under GAAP for external financial

reporting, drove the management and investment decisions at Xerox. The pitfall of this philosophy is to allow no room for *qualitative considerations* (Kaplan & Norton, 1996). Full costs, profits and ROI measured based on historical costs are incomplete measures. They are short-run measurements and so they could not foretell performance in the future. Other decision intangible variables to be considered include customer satisfaction and acceptance, market share, and the competitive advantage that comes from a unique product – this is the so-called balance scorecard approach in the performance measurement literature (Kaplan & Norton, 1996). These intangible decision variables were ignored by the Xerox management. Johnson and Kaplan (1991, p. 3) summarize the above thoughts as follows:

> **"Today's management accounting systems provide a misleading target for management attention and fail to provide the relevant set of measures that appropriately reflect the technology, the products, the process, and the competitive environment in which the organization operates. Originally designed in this century to help coordinate the diverse activities of emerging vertically integrated enterprises, financial measures such as return on investment (ROI) have become for many organizations the only measure of success. Financial managers, …, become isolated from the real value-creating operations of the organization and fail to recognize when the accounting numbers are no longer providing relevant or appropriate measures of the organization's operations."**

Contrary to DuPont's use of ROI as just one of several tools for managers to consider, Xerox appears to have relied heavily on ROI and profitability measures to ground and drive their decision-making process.

The End of SDS & Restructuring

The eventual demise of SDS along with the U.S. recession in 1972 made oversight of operational management at Xerox much more acute. SDS losses eventually amounted to $180 million in 1974, leaving McColough little choice but to find a way to discontinue the operations of SDS. In 1975, the board of directors approved his request to write off the investment in and operational losses of SDS, which totaled almost $1.3 billion, dubbing it "McColough's folly" (Strassman, 2008). Xerox restructured its computer and copier businesses into three large functional groups. This resulted in the elimination of Goldman's authority over developing products for emerging inventions at PARC. This impeded an important voice in attempting to communicate PARC developments to Xerox corporate as Goldman could no longer advocate on behalf of the engineers at PARC. The new organizational structure also resulted in Jim O'Neill, a former Ford financial executive, being assigned to head the newly-formed Information Technology Group (ITG) consisting of the computer and copier businesses. PARC was subsequently rolled under O'Neill's authority. The authority over new product development was no longer in the hands of Goldman who had supported McColough's dream of *architectural information*, but instead fell into the hands of McCardell (Xerox's President) and O'Neill both of whom were groomed under Ford's philosophy of "management by numbers". Both were strong proponents of decision making that was grounded on costs, market share and profits which left little room for qualitative considerations. A management control system that relied on key financial metrics to make strategic decisions was a cornerstone for both O'Neil and McCardell's decision making process.

INSIGHTS FROM THE OPPORTUNITIES LOST AT PARC

So many opportunities were squandered by Xerox due to the fact management took a short-term view towards investment—the view of analyzing investments in terms of accounting concepts of full cost, profit, and return on investment to the exclusion of some important but intangible variables such as new market creation, customers' satisfactions, corporate image and continuity of organization growth. Xerox's reliance on conventional cost absorption techniques to determine product costs for controls and decision making, made them the victims of their own measurement practices. Being unable to look to the strategic cost

concepts of variable costing, target costing and activity-based costing led McCardell and O'Neill to inevitably reject the inventions created at PARC. Their rejection of these opportunities, in favor of what their accounting and financial metrics presented, is ostensibly seen as one of business history's greatest missed-opportunities.

PARC was treated primarily as a research and development site but in practice was weighed down by its perceived inability to fuel products that would generate profits. This perception of PARC lost sight of the potential new markets and new streams of revenue that could have been developed. These mistakes at Xerox give us a historical blueprint of methods to be wary of when implementing and running R&D facilities and laboratories. Financial metrics can be invaluable, but they only provide a financial snapshot of a fixed point in time for any organization. Relying on such information must come with the caveat that it is just a tool for decision making, not the final arbiter for a decision.

Launching a new product is typically not a short-term decision, but a long term one—which requires quantitative analysis that can span years, such as the decade long effort by DuPont to create a market for nylon products. A negative or low ROI during the first few years of an investment can easily lead to rejecting potentially game-changing developments. McCardell and O'Neil who were numbers-based, risk-adverse decision-makers were unable to look beyond an interim view of PARC's research and product development efforts. Unlike their peers at DuPont, they did not have a good understanding of PARC or the potential they were being presented. When looking at long-term development efforts, especially those that delve into highly innovative spaces, a strong understanding of the potential innovations (and eventual products) being developed must be coupled with an understanding of the organization's strategy. While the key decision makers at Xerox during the 1970's had a strong understanding of the financial metrics, they lacked a fundamental understanding of the innovative technologies they were developing. This understanding of the technology was a crucial part of DuPont management's successful use of the ROI metric with products by nylon.

The story of Xerox PARC's early years has been viewed under the lens of organizational rigidities, managerial short-sightedness, and strategic decision-making at both its best and worst. These perspectives must also be blended with the financial perspectives that this research has endeavored to highlight. Understanding the management control systems and financial measurement tools that were employed at Xerox, give us a deeper understanding of *why* and *how* the decision makers were strategically short-sighted within their organizationally rigid management structure. Analogous to PARC's numbers driven decision to locate production at Dallas as opposed to California, there is more than just one side (in this case the numbers-driven side) to any decision. Though this may seem prosaic, examining decisions from multiple-sides can be difficult to achieve in practice (Pisano, 2019; Teresko, 2001; Teece, 1998; Teece et al., 1997).

The story of PARC shows us how incredible creations are possible, given the appropriate environment, and how firms should be more cognizant of a more comprehensive approach towards managing such projects. It is easy, now, to be highly critical of what occurred at PARC, such as Steve Jobs comments about Xerox during a 1996 interview:

> **Xerox could have owned the entire computer industry today. Could have been, you know, a company ten times its size. Could have been the IBM of the nineties. Could have been the Microsoft of the nineties.**

While it may be too late for Xerox to dominate the computer industry, firms today can still learn from the mistakes committed by Xerox in their management of PARC. Research and development must eventually find grounding towards product design where creations and innovations are geared towards practical use. Much like DuPont's development of nylon, research for the sake of knowledge must eventually be refocused towards application and use. While the use of financial metrics such as ROI are important management tools, they must be balanced with an understanding of the expanded time-frame required for adequate creation and development. They also require knowledgeable interpretation by leaders/executives who have a firm grasp of not only their respective companies but of the innovative products they wish to deploy into the marketplace. Otherwise, these tools may lead to detrimental and short-

sighted decision making. The contributions developed at PARC during its incredibly dynamic and productive early years should be remembered for what is possible and for what is not possible through financial control systems alone.

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