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Lessons from 3M Corporation: managing innovation over time and overcoming the innovator's dilemma

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Abstract

This thesis explores how large global incumbents manage innovation over time and overcome the innovators dilemma with empirics from the 3M Corporation. The research question has been investigated through the application of the three perspectives described in Yu and Hang's (2010) article: (1) The internal, (2) The customer and (3) The technological perspective. To gain a longitudinal perspective of 3M's innovation management a combination of secondary and primary sources has been used. Findings suggest that the perspectives seem to possess some explanatory power and that the various enablers are connected, hence, stressing the need of more holistic theories including the various perspectives when regarding disruptive innovation and innovation management. Moreover, findings suggest that to enable disruptive innovation management and overcome the innovators dilemma, it is indeed important to have supportive human resources, a flexible organizational culture with the ability to unlearn, allocating resources between both sustaining and disruptive innovations, having an organizational structure allowing for different sizes and autonomy of units and facilitating various ways for knowledge sharing and collaboration. Additionally, having a broad customer orientation open to include new customers and emerging markets, along with tools to understand customers' latent needs and to systematically search for and develop disruptive innovations specifically.

Key-words: Disruptive innovation, Innovation theory, Innovator's dilemma, 3M Corporation, Continuous innovation management

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1. Introduction

This section begins with a short background setting the scene for the research, followed by of the research question that this paper seeks to answer. Ending with a brief discussion on sustainability aspects and a description of the structure of the paper.

1.1 Background

Innovation theory is a subject that has been extensively researched. Schumpeter (1942) point out innovations important role for firms' survival and as Baumol (2002:1) puts it: "Under capitalism, innovative activity... becomes mandatory, a life and death matter for the firm...". Comparing competition through efficiency and competition through innovation, it becomes clear that tackling competition through innovation is far more effective than through efficiency (Schumpeter 1950 cited in Conceição et al., 2002). Innovation can also be an effective tool for new firms to successfully enter the market and undermine incumbent firms (Cefis & Marsili, 2005; Christensen, 1997), thus, innovation is necessary in order for established firms to keep their competitive advantage when disruptive innovations enter the stage (Christensen et al., 2007). Disruptive innovation, meaning that an actor, usually a new firm, comes up with a cheaper, simpler or more convenient innovation that allows them to undercut the competitive advantages of powerful incumbents (Christensen, 2007).

A phenomenon coined the Innovator's Dilemma by Christensen (1997) highlights the challenge of managing innovation both for sustaining i.e. improving existing products and for developing new disruptive and breakthrough innovations. Disruptive innovations cause problems as they initially do not satisfy the demands of even the high-end market. Large firms may have barriers to innovation which make it difficult to invest in disruptive innovations early on and they commonly overlook these innovations. Eventually however, the disruptive innovations might surpass the existing products in the market and when this happens, the large firms that did not invest in the disruptive innovation earlier are left behind, losing their leading market position and they might even end up dying (Christensen, 1997). I.e. the innovators dilemma describes the difficulties in knowing when to put the innovation effort into improving existing products and when to invest in new disruptive innovations, even though the presence of cannibalizing the own products. Albeit it is commonly observed, incumbents do not necessarily have to end up dying due to disruptive innovations (Yu & Hang, 2010). Additionally, evidence stress a net effect of total market growth in every industry changed by disruption and incumbents similarly to entrants, can use disruption as a powerful growth mechanism through new market discovery (Gilbert, 2003). Hence, to understand continuous innovation, understanding the process of disruptive innovations is indeed vital.

In recent years, the speed of new product development has drastically increased; product lifecycles have been reduced by half or more, and this trend is foreseen to continue (Assink, 2006), stressing the need for innovation and understanding of how innovation is achieved. Additionally, many are talking about the digital disruption that currently is taking place and how digitalization is changing the conditions and breaking established processes and changing the progress in a disruptive manner (Sandström & Karlson, 2016). Newlands (2016) also argue that 2017 will experience more innovative and evolutionary disruption than ever before, with more connection, more automation, and more significant impact in business and investment. Leading to changing consumer preferences and societal needs, demanding new business processes, thus creating a creative destruction of new markets being born while others die out and the process is occurring in a rapid speed, in an everlasting global and connected world (Sandström & Karlson, 2016). Stressing the need for a deeper investigation of disruptive innovation and overall innovation management over time.

Even though the phenomenon of disruptive innovations has been extensively researched (e.g. Christensen, 1997, 2007; Yu & Hang, 2010; Danneels, 2004; Assink, 2006; Paap & Katz, 2004) not many theories are useful in actually guiding firms on how they should act to continuously manage it; hence, Thomond and Lettice (2002) state the need for a deeper understanding of the subject with specific tools enabling firms to create and exploit the opportunities of disruptive innovations. To gain a deeper understanding and suggesting specific tools one must first explore how firms that have managed innovation for a longer time period have been managing innovation.

1.2 Research question

As innovation is vital for firm survival and because of the pressing threats of disruption and creative destruction it is important to gain more insight on the process of managing innovation, especially disruptive innovation. Therefore, the aim of this research paper is to explore how large global incumbents manage innovation over time, with the purpose of contributing to the theory of disruptive innovation. Thus, the research question is:

How do large global incumbents manage innovation over time and overcome the innovators' dilemma?

The concept of managing innovation is discussed with guidance from Yu and Hang's (2010) different perspectives (the internal, the customer and the technological perspectives) for the enablement of disruptive innovation. Including concepts of human resources (HR), organizational culture, resource allocation, organizational structure, customer orientation and needs and systematic approaches for identifying and creating disruptive innovations. Using the single case study method with empirics from the case of 3M Corporation, this paper seeks to explore how 3M has managed to constantly stay innovative and how they have managed disruptive innovations and the innovator's dilemma, aiming to contribute to the theory of disruptive innovation and to the fields of economics, organizational theory and innovation theory. However, this thesis aims to explore innovation management at large not only focusing on disruptive innovations. As the

empirics come from the single case of 3M, findings only regard how 3M has managed innovation over time, hence, the result cannot be generalized to all large global firms. Yet, it can explore the theory further and generate insight on how large global firms might manage innovation based on the investigation of 3M.

1.3 Sustainability aspects

Innovation processes towards sustainable development have received increasing attention in academic literature and many sustainable innovations are directed at improving technological processes (eco-efficiency) and to lower costs of production i.e. incremental innovations; however, companies with sustainability integrated in their orientation and innovation processes show value creation through the development of products that are new to the market i.e. radical innovations and cooperation with stakeholders (Bos-Brouwers, 2010). Hence, the management of continuous innovation and disruptive innovation can be analyzed from various perspectives. For example, how it is managed with regards to environmental issues and corporate sustainability efforts. However, this paper does not include any analysis on how firm's management of innovation might affect the environment or other sustainability aspects. Other perspectives to consider might be how firm's innovation management affects the economy and society as a whole, how disruptive innovations change the economy, society and our environment or how firms manage sustainable entrepreneurship. Sustainable entrepreneurship is characterized by entrepreneurial activities which are less oriented towards management systems or technical procedures, and focus more on the personal initiative and skills to realize large-scale market success and societal change with environmental or societal innovations (Schaltegger & Wagner, 2011). Nevertheless, this research will not address how firms' innovation management might affect the economy or the society or how they manage sustainable entrepreneurship. It aims only to explore the phenomenon of how firms manage innovation and disruptive innovations, not the different societal implications of firms' innovation management and the development of disruptive innovations.

1.4 Outline of thesis

The thesis is structured as followed. In the ensuing section a brief review of previous literature in fields such as innovation, disruptive innovation and firm survival is described, leading to a presentation of the research gap that this paper seeks to fill. Followed by section 3, where the theoretical framework consisting of Yu and Hang's (2010) research is explained. Subsequently, in section 4, the applied methodology is discussed, describing the choice of using a single case study, how the case has been selected, how data has been collected and the operationalization that has been applied in the data collection and analysis. Ensuing section 5 includes a presentation of the main empirics, structuring the raw data into Yu and Hang's (2010) theoretical framework. Followed by section 6 which consists of an analysis and discussion of the findings, followed by a concluding section 7 of the results and implications of the study, answering the research question and proposing future research suggestions. Finally, ending with a reference list and an appendix.

2. Literature Review

This section briefly presents an overview of previous literature in the fields of innovation, disruptive innovation and firm survival. Concluding with presenting the gap in previous literature that this paper aims to fill.

2.1 Innovation

First and foremost, there is a distinction between innovation and invention. According to Freeman (1982:7) “*an invention is an idea, a sketch or model for a new or improved device, product, process or system*” whereas “*an innovation in the economic sense is accomplished only with the first commercial transaction involving the new product, process, system or device, although the word is often used to describe the whole process*”. This paper seeks only to address the concept of innovation, especially focusing on Christensen’s (2004) Sustaining and Disruptive Innovation which will be explained in-depth later on.

Schumpeter (1942) was one of the first who emphasized the important role innovation plays in the social and economic context, arguing that a phenomenon called “creative destruction” occurs when innovation replaces old routines and behaviors with new habits and as Utterback (1994:11) puts it: “*Innovation is the creator and destroyer of industries and corporations*”. Additionally, Baumol (2002) stress that innovation is the driving force behind the growth miracle of capitalism yet innovation has not received appropriate attention in research. Baumol argues that innovation does not belong on its periphery but at the core of microeconomics, because innovation rather than price is the primary competitive dimension and less innovative firms will find their markets shrinking as they lose business to their more innovative competitors. Tidd (2001) also stress that decades of research on innovation have proved futile in providing clear and consistent findings or coherent advice to managers. Hence, innovation theory is highly interesting to study.

Moreover, Cefis and Marsili (2005) investigate the impact of innovation on firm survival and find that there is a marked difference between innovators and non-innovators even when controlling for the effects of firm size, growth and nature of technology. Hence, concluding that there is an “Innovation Premium” i.e. firms’ ability to innovate increases the survival probabilities for all firms and across most industrial sectors. This innovation premium entails that innovation increases firms’ survival probability with 11 % and for process innovation it increases the survival time by 25 %. Stressing innovations play a key role in enhancing the chances of survival and in creating competitive advantage for firms. For science-based firms, innovation *per se* is not enough to enhance survival, hence, suggesting that innovation should be combined with various firm specific capabilities such as technological, organization and commercial to enable efficient exploitation of innovation and to create a premium in survival (ibid). Thus, it is important to understand the innovation process and how firms can manage innovation.

The complexity of innovation is that there is no standard measurement for how to capture the effects of innovations and it is particularly difficult to compare between industries as the measurements differ significantly amid industries, what works for one industry might not be suitable for another (Tidd, 2001). For a full list of the various measurements and their respective strengths and weaknesses go to Tidd, 2001. Moreover, the rules of engagement in innovation management continually change, thus, companies' must adapt (Odenthal et al., 2004).

2.2 Disruptive Innovation Theory

Building on Schumpeter's creative destruction Christensen (1997; 2003; 2004) divide innovation into Sustaining and Disruptive. Sustaining innovations move companies along established improvement trajectories i.e. improvements to existing products or services that are valued by customers e.g. computers that process faster, mobile phone batteries that last longer or cameras with better quality images. Disruptive innovations, on the other hand, introduce a new value proposition and either create a new market or reshape an existing market. According to Christensen et al. (2004), there are two types of disruptive innovations, low-end and new-market; low-end occurs when existing products or services are "too good". Examples of low-end disruptors could be Walmart's discount retail store and Dell's direct-to-customer business (ibid). New-market disruptive innovations can take place when existing products and services are inconvenient or difficult for customers. Apple's personal computers and eBay online marketplace are examples of new-market disruptive innovations and they both created new growth by simplifying for customers to do something that historically demanded high expertise. Hence, disruptive innovations bring consumption to what Christensen et al. (2004) calls "nonconsumers" or "nonconsuming contexts". Christensen's Disruptive Innovation theory is illustrated in the figure below (Figure 1). Consequently, incumbents tend to win the sustaining battles and start-ups tend to win the disruptive battles, something that will be discussed more later. Established competitors have powerful motivations to fight sustaining battles and they have the resources to win, meanwhile entrants have the ability to act in a flexible manner and are more open to address smaller niche markets.

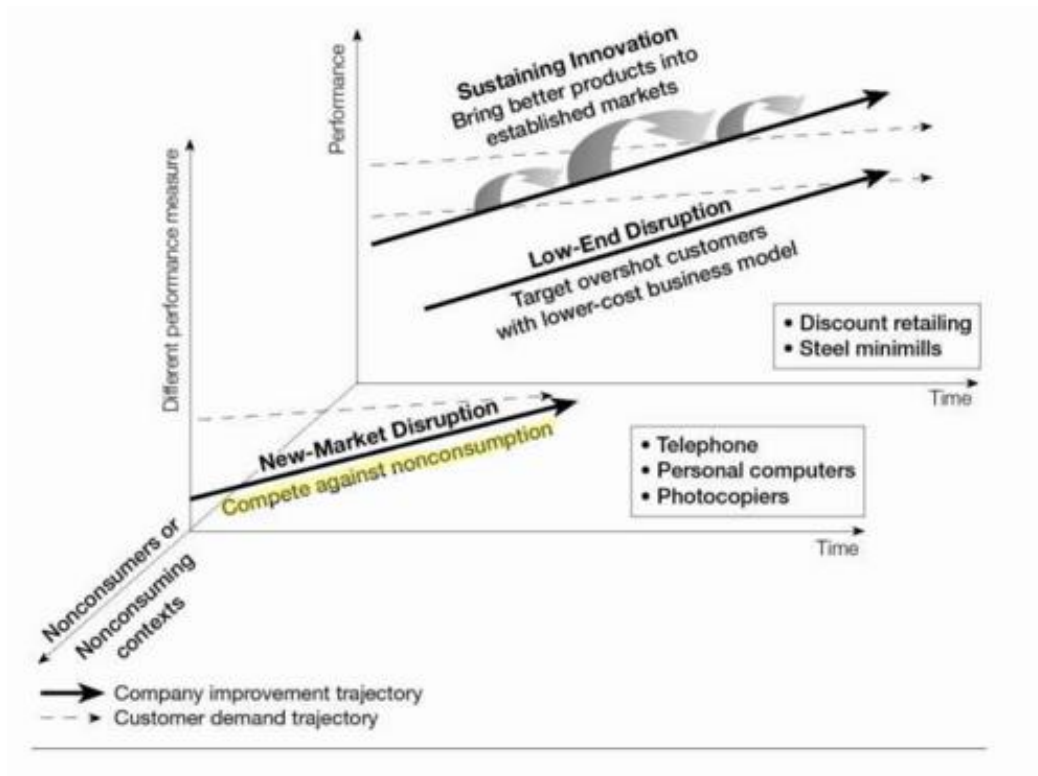


Figure 1. *The disruptive innovation theory*

Source: Christensen et al., 2004: xvi

According to Christensen’s model, disruptive innovations tend to attack the main market from below (low-end or new-market), however, this view has been challenged by Utterback and Acee (2006) and Govindarajan and Kopalle (2006) who argue that disruptions can indeed occur by the introduction of higher performing and higher priced innovations attacking the main market from above. Therefore, disruptive innovations can be more radical in nature and high-end as well (Govindarajan & Kopalle, 2006). For example, digital cameras relative to analog cameras, cellular phones relative to wired phones, iPod relative to Walkman, and electronic calculators relative to slide rules are all more radical disruptions (ibid). High-end disruptive innovations also create a dilemma for incumbents as (1) conventional customers do not value the newer performance features at the time of introduction; (2) the innovation performs poorly on the attributes existing customers value; (3) the innovation initially attracts an emerging, or an insignificant, niche market; and (4) despite the innovation might offer a higher per-unit margin, the perceived lower market size makes the profit potential seem insignificant (ibid).

2.3 Firm survival

There are various competing explanations for the survival of firms, commonly argued is that firm survival is positively correlated with firm size and age (Geroski, 1995; Sutton, 1997). In addition, Cefis and Marsili (2005) find evidence of an innovation premium suggesting that innovative firms have a greater chance of surviving. Nevertheless, Foster and Kaplan (2001) investigated the life expectancy of firms in the Standard & Poor (S&P) 500 and showed that in 1935, the average expectancy was 90 years and by 1975, that number had dropped to 30 years, and in 2005 it was estimated to be only 15 years; hence, being large and successful at one point in time is no guarantee of continued survival. Moreover, Louca and Mendonca (2002) stress that most firms do not adapt and are thus replaced. Likewise, Conceição et al., (2002) stress that the most common outcome for large firms created in the beginning of the 20th century, with giant managerial hierarchies and large market and first mover advantages, is indeed failure.

Despite the high rates of failure some firms survive and prosper over long periods of time (Hill & Rothaermel, 2003; O'Reilly & Tushman, 2008; Yu & Hang, 2010; Conceição et al., 2002). Moreover, with regards to disruptive innovations, it is frequently observed that new firms enter the market and triumph over powerful incumbents with a cheaper, simpler or more convenient innovation (Christensen et al., 2004). As an empirical phenomenon, incumbents' failure to embrace new technology has been observed repeatedly over the years, in numerous studies (e.g., Abernathy & Utterback, 1978; Christensen, 1997; Cooper & Schendel, 1976; Foster, 1986; Henderson & Clark, 1990; Rosenbloom & Christensen, 1998; Sull, Ted-low, & Rosenbloom, 1997; Tripsas & Gavetti, 2000; Tushman & Anderson, 1986; Utterback, 1994). Likewise, Paap and Katz (2004), note that in every industry studied, leading firms challenged with a period of discontinuous change tend to fail to sustain its industry market leadership in the new technological era. Therefore, even large firms that in theory have great advantages compared to small firms are not immune to the destructive power of innovation by other firms (Conceição et al., 2002). Nonetheless, incumbents do not have to end up dying, there are some examples of firms that have adapted and prospered to changes that disruptive innovations bring (Christensen, 2004; Hill & Rothaermel, 2003; O'Reilly & Tushman, 2008; Yu & Hang, 2010). For example, IBM started as a manufacturer of mechanical office equipment but today they are primarily a service and consulting company. Though IBM stands as a survivor today, they are commonly portrayed as a classic example of a company that ignored the force of disruptive innovations. IBM dominated the market with their mainframe computers, however, when the disruptive personal computers entered the market IBM's leading position quickly came to an end (Christensen & Raynor, 2003), stressing the complex nature of disruptive innovations. Nevertheless, disruptive innovations have killed many established industry leaders and will continue to do so, but, it has simultaneously created a net effect of total market growth in every industry changed by disruption (Gilbert, 2003). Moreover, incumbents just like entrants, can use disruption as a powerful growth mechanism through new market discovery (ibid).

2.4 Challenges of Disruptive Innovations

First off, there is no concise and coherent definition of disruptive innovations which complicates the ability to build on previous research (Yu & Hang, 2010; Danneels, 2004). Similar to Christensen's categories Sustaining and Disruptive Innovation many authors divide innovation into two broader strands, however, the terminology of the two categories has changed through time and there is no one single distinction (Yu & Hang, 2010). Generally, it can be divided into: (1) revolutionary, discontinuous, breakthrough, radical, emergent, step function technologies, exploration, disruptive or competency destroying; (2) evolutionary, continuous, incremental, 'nuts and bolts' technologies, exploitation, sustaining or competency enhancing (Florida & Kenney 1990; Morone, 1993; Utterback, 1994; Christensen, 1997; O'Reilly & Tushman, 2008). Accordingly, Danneels (2004) argues that in the absence of a reliable and valid instrument to measure disruptiveness of innovations, efforts at understanding this concept is limited.

Moreover, the theory itself has evolved though time, in the beginning Christensen (1997) first called it Disruptive Technology but later on he realized that it was not only technologies that could disrupt but also services and business models, hence, Christensen and Raynor (2003) broadened the concept to Disruptive Innovations to incorporate innovations within services and businesses as well. However, this broader definition has been criticized by e.g. Markides (2006), who argues that there is a fundamental difference between disruptive technologies, disruptive products and disruptive business model innovations; they arise in different ways and create different competitive effects which require different responses, thus, they need to be differentiated. But, Yu and Hang (2010) agree with Christensen and Raynor on broadening the concept as it is a more suitable term to describe the entire phenomenon, as business model innovations are deeply involved. The core of the definition lies in understanding the difference between sustaining and disruptive innovations where sustaining is competency enhancing innovations meanwhile the disruptive are competency destroying (Yu & Hang, 2010). Additionally, as previously stated the theory has also been extended to include low-end, new-market and high-end disruptive innovations as well, allowing attacks to come from above as well as below.

Secondly, Disruptive Innovations are difficult to study as it is a relative term, for example, an innovation that disrupts one firm/market might be sustaining to another (Christensen & Raynor, 2003). Moreover, it is a process rather than a product or service at one point in time, referring to the evolution of products and services over time (ibid). Thus, it is difficult to use the disruptive theory to predict disruptions before they happen (Danneels, 2004), yet, as Christensen (2006: 45) argues "*...one cannot think a thought before it has been thought. All that must be asked of a theory, however, is that it help to evaluate a technology after it has been conceived or to evaluate a business venture after it has been proposed or launched.*".

Furthermore, Paap and Katz (2004), explore how firms can anticipate disruptive innovations and identify that firms indeed can anticipate and understand the disruptive innovation in question but incumbents rarely seem to draw the connection to the change it will create to consumer needs and market conditions. Subsequently, focus should lie on understanding customer and operational needs instead of searching for the next big disruptive innovation (ibid). Nevertheless, firms cannot simply address what their current customers are asking for as most consumers do not know what they need until it stands before them. Thus, only considering what consumers ask for might lead to missing the next wave of innovation thus being caught in the Innovator's Dilemma and investing too late in disruptive innovation.

Thirdly, Disruptive Innovations often act in an unknown environment being the first to exploit newly created markets or addressing new customers that previously have not been targeted before, thus, both the market and customers are unknown and there is scarce information available for supporting investments in disruptive innovations. Consequently, it can take time for these innovations to disrupt and because disruption can take time, incumbents frequently overlook disrupters (Christensen, 1997; 2004). Contrary, Gilbert (2003) identify the issue that disruptions often take time as an opportunity for incumbents to react before the disruptive business encroaches heavily on the established market. Nevertheless, incumbents tend to oversee the force of disruption as entrants that prove disruptive begin by successfully targeting segments that incumbents have overlooked, gaining a competitive position by delivering more suitable functionality or price. Incumbents, looking for higher profitability in more demanding segments, tend not to respond forcefully. Subsequently, entrants then move upmarket, delivering the performance that incumbents' mainstream customers require, while preserving the advantages that drove their early success. Once mainstream customers start adopting the entrants' offerings in volume, disruption has occurred. Therefore, it is vital that incumbents look beyond their current customers (Gilbert, 2003; Paap & Katz, 2004). Moreover, incumbents tend to at a higher degree fall into the familiarity trap, also known as the tyranny of success, suggesting that existing successful products, designs or technologies inhibit firms' willingness to take on risky initiatives making incumbents prisoners of their own successful business models (Ahuja & Lampert, 2001; Christensen & Raynor, 2003; Assink, 2006; Slater & Mohr, 2006; Conceição et al., 2002), unable to unlearn old routines (Paap & Katz, 2004).

Finally, the challenge of the Innovator's Dilemma (Christensen, 1997) or Dualism (Paap & Katz, 2004) also complicates the theory of Disruptive Innovations. As Paap and Katz (2004:1) puts it: *“Organizations in today's hypercompetitive world face the paradoxical challenges of “dualism”, that is, functioning effectively today while innovating effectively tomorrow”*. Likewise, Christensen (1997) discuss this phenomenon as the Innovator's Dilemma i.e. following a sustaining innovation path can make sense in the short run but can condemn the firm to failure in the long run. Yet dedicating valuable resources to a niche and unproven opportunity can also lead to the failure of the firm. In other words, Christensen et al., (2002: 1) explain the dilemma as: *“Most managers*

understand that significant, new, sustainable growth comes from creating new markets and ways of competing. But few of them make such investments. Why? Because when times are good and core businesses are growing robustly, starting new generations of growth ventures seems unnecessary; when times are bad and mature businesses are under attack, investments to create new growth businesses can't send enough profit to the bottom line quickly enough to satisfy investor pressure for a fast turnaround." Thus, it is vital to have a forward-looking perspective when evaluating whether to invest or not in new or immature disruptive innovations; can the niche market or customer segment grow and mature enough to impede on our core business and does it make sense investing today in the long run at the risk of cannibalizing ourselves (Christensen, 1997; 2004). In addition, O'Reilly and Tushman (2008:10) discuss exploitation, exploration and ambidexterity arguing that: "*Exploitation is about efficiency, increasing productivity, control, certainty, and variance reduction. Exploration is about search, discovery, autonomy, innovation and embracing variation. Ambidexterity is about doing both.*". Emphasizing the need to simultaneously address both types of innovation as the routines, processes and skills required are fundamentally different with different success factors that in some cases even can be contradicting (ibid). O'Reilly and Tushman (2008), stress the imperative role senior teams' play in creating dynamic capabilities which enable both exploitation and exploration as a possible solution for the Innovator's Dilemma. However, Yu and Hang (2010), argue that disruptive innovations experience difficulties in attracting the same attention from senior managers and existing customers, hence, the theory of ambidexterity might not be compatible with disruptive innovations.

2.5 Incumbents failure to adapt and inhibitors to disruptive innovation

Because incumbents usually outperform entrants in sustaining innovation contexts but tend to underperform in disruptive innovation contexts, it is interesting to explore the phenomenon from incumbent's perspective. Previous literature has focused a lot on established firms that have failed to adapt to disruptive innovations (Lucas & Goh, 2009; Christensen & Bower, 1996; Christensen, 1997). Christensen (1997; Christensen & Bower, 1996) researched the disk drive industry and noted that disruptive innovations consistently resulted in the failure of the industry's leading firms. Moreover, Lucas and Goh (2009) investigated how Kodak missed the digital photography revolution. In addition, Sandström et al, (2009) conducted an in-depth case study of Hasselblad, a Swedish manufacturer of professional cameras. The case highlights the complexities of disruptive innovations and how Hasselblad was at first failing to cope with the disruptive transition from analogue to digital camera technology but being close to bankruptcy the firm eventually managed to survive. They argue that incumbents' ability to manage disruptions and solve the innovator's dilemma depend upon the particular characteristics of an incumbent, something that has been neglected in previous research.

Furthermore, Assink, (2006) is through an extensive literature review able to identify several key inhibitors or barriers that negatively affect firm's ability to cope with disruptive innovation. Assink (2006) divides the inhibitors into five groups: (1) the adoption barrier, (2) the mindset barrier, (3) the risk barrier, (4) the nascent barrier and (5) the infrastructural barrier. Correspondingly, Yu and Hang (2010) also identify similar inhibitors, however, using four different perspectives: (1) the internal, (2) the external, (3) the customer/marketing perspective and (4) the technological perspective. In addition, Yu and Hang (2010) also identify enablers for disruptive innovation capabilities using the same four perspectives. These enablers will be described in more detail in the theoretical framework chapter.

2.6 Research gap

In all, findings in previous literature focus on why leading established firms die or struggle when they face disruptions and where the firms that failed to adapt went wrong (e.g. Christensen, 1997; Christensen & Bower, 1996; Assink, 2006; Lucas & Goh, 2006). Focus in previous research, seems to be on one particular disruption that has occurred and how firms have managed or failed to manage it. Entrant firms that have attacked incumbents and created disruption has also gained attention in previous literature as empirical research generally suggest that discontinuous and disruptive innovations are developed and commercialized by new entrants (Anderson & Tushman 1990; Christensen & Bower 1996; Foster 1986; Henderson & Clark 1990; Tushman & Anderson 1986). Moreover, modern research has focused on surveying previous literature (Danneels, 2004; Yu & Hang, 2010; Markides, 2006; Assink, 2006; Paap & Katz, 2004, O'Reilly & Tushman, 2008) stressing the need for more empirical and exploratory research. Additionally, Thomond and Lettice (2002) state the need for a deeper understanding of disruptive innovation with explicit tools enabling firms to create and exploit the disruptive opportunities. Likewise, Tidd (2001) stresses that there is a lack of clear and consistent findings and coherent advice to managers. In view of this, there is need for more research aimed at exploring possible tools and strategies for incumbent firms to utilize. In addition, Sandström et al, (2009) point out that more research is needed on disruptive innovation and the particular characteristics of incumbents. Yu and Hang (2010) also suggest that there is a need for a more complete analysis of disruption identifying precisely which combinations of the enablers that is most important. To gain a deeper understanding and suggesting specific tools one should begin by exploring how firms that have managed innovation for a longer period of time have been managing innovation and disruptive innovations.

Therefore, this paper aims to explore how large, global incumbents manage innovation over time with empirics from the case of 3M Corporation. Using Yu and Hang's (2010) summarizing framework of the many enablers for disruptive innovation as a point of departure, the purpose of this research is to contribute to the theory of innovation management, and thereby to the fields of economics, organizational theory and innovation theory.

3. Theoretical Framework

To explore the theory of innovation management further, seeking a deeper understanding of how large global incumbents manage innovation over time and overcome the innovator's dilemma, Yu and Hang's (2010) theory of possible enablers have been applied. Since Yu and Hang conducted an extensive literature review to identify their list of enablers it is relevant to apply their theory on a new case (3M) to further explore the theory(s). As previously mentioned, their framework is divided into four perspectives: (1) the internal, (2) the external, (3) the customer/marketing perspective and (4) the technological perspectives. These perspectives are summarized below based on the findings in Yu and Hang's (2010) literature survey.

3.1 The Internal perspective

The internal perspective focuses on enabling disruptions from the organization itself and is divided into four different dimensions: Human Resources, Organizational culture, Resource allocation and Organizational structure. Indicating that firms' internal aspects can affect their ability to manage and react to disruptive innovations. For example, with regards to human resources, senior and middle management can both be an inhibitor and an enabler. If they do not understand the potential that lie in disruptive innovations they are more likely to focus on traditional sustaining innovations (Christensen & Raynor, 2003) as their knowledge is deeply entrenched and largely shaped by their current experience (Henderson, 2006). Therefore, Christensen and Raynor (2003) argue for the usefulness of having an additional team at the corporate level that is mainly responsible for collecting disruptive ideas and putting them into action. Their incentives also play an imperative role, if managers have short-term incentives they might avoid the risks of investing in disruptive innovations (Govindarajan & Kopalle, 2006; Yu & Hang, 2010) and they might allocate their resources towards sustaining innovations that boost their careers instead (Christensen & Raynor, 2003; Denning, 2005). In addition, there seems to be a difference between founders and professional managers in disruptive innovations, as founders seem to have a better ability to tackle disruptions as they have more self-confidence (Christensen & Raynor, 2003).

The composition and attitude of non-management employees at a firm can also affect their ability to manage disruptive innovations. Successful disruptive projects tend to consist of teams with risk-taking members that have outside expertise (Murase, 2013). Moreover, Christensen argue that when it comes to decision making, it can be significantly more productive in regard to disruptive innovations allowing employees that have direct contact with markets and technologies to conduct first-level screening and shaping themselves than relying on business development departments and traditional analyst laden corporate strategy. Furthermore, as many disruptive ideas are founded by frustrated ex-employees from incumbent companies, firms should capture this talent e.g. through the creation of spin-offs before they leave. (ibid)

Organizational culture is important as it can facilitate coordination within a firm, and as such substitute for strict formal control systems (Tushman & O'Reilly, 2002). On the other hand,

organizational culture can also create cultural inertia which is difficult to overcome and often results in the failure of introducing any substantial change even though it is highly needed (Christensen & Raynor, 2003; Tushman & O'Reilly, 2002; Henderson, 2006). Therefore, an enabler for disruptive innovations could be that the firm is prepared for organizational changes and that there are processes in place for how to unlearn deeply rooted routines and values (Christensen & Raynor, 2003; Baker & Sinkula, 2005). Moreover, a culture that includes traits such as entrepreneurship, risk-taking, flexibility and creativity are favorable when developing disruptive innovations (Govindarajan & Kopalle, 2006; Murase, 2013).

Furthermore, resource allocation could be an inhibitor for disruptive innovations if there are structured routines (Nelson & Winter, 1982) such as evaluating projects based only on financial results (Christensen, 2006) and relying on traditional market reports. To overcome this, firms should instead have different evaluation routines when evaluating emerging disruptive projects compared to existing business projects (Yu & Hang, 2010). Resource dependence can also snare firms into specific businesses in which they have already acquired certain resources (Christensen, 2006). Consequently, they often try to increase their competitiveness by intensifying their investments to improve current technologies or products used by the current customers (Christensen & Bower, 1996), therefore, likely missing the opportunity for new disruptive innovations. Hence, firms should allocate their resources and investment decisions into separate and independent processes for sustaining and disruptive projects (Chao & Kavadias, 2007; Hogan, 2005).

A firm's organizational structure, such as the size and structure of the firm and its business units and its collaboration with start-ups and with other incumbent firms can also affect the management of disruptive innovations (Yu & Hang, 2010). It is commonly argued that R&D investments are more effective for small compared to large firms (Lee & Chen, 2009; Lejarraga & Martinez-Ros, 2008) and the size of firms is negatively correlated to the success of disruptive innovations (Christensen & Raynor, 2003; DeTienne & Koberg, 2002; Tushman & O'Reilly, 2002). Large firms can keep their flexibility by organizing in smaller business units. On the other hand, this can lead to higher overhead costs and inefficiency. Thus, Christensen argues for the need to set up an autonomous organization to develop and commercialize new ventures. The autonomous organization can be a spin-off or a business unit that has complete autonomy so that the employees of that organization have the ability and freedom to create an appropriate business model for the specific situation (Christensen, 2006). Yet, the key dimension of autonomy regards processes and unique cost structures rather than geographical separation or ownership (Christensen & Raynor, 2003). Conversely, some argue for the possibility to possess dual resources, processes and values to manage both sustaining and disruptive innovation. Tushman and O'Reilly (2002) propose the concept of ambidexterity as an ability to simultaneously pursue both incremental and radical innovation to improve technology and satisfy existing customers, but, disruptive innovations, due to its initial inferior performance, seems not to attract senior managers and existing customers (Yu & Hang, 2010).

Moreover, start-ups have innovative and potential disruptive technology strengths, yet at the same time, they lack complementary assets that incumbent firms have (Rothaermel, 2001), hence, spin-offs, strategic alliances and acquisitions (Claude-Gaudillat & Quelin, 2006) and other types of collaborations can be seen as an enabler for surviving and managing disruptive innovation (Macher & Richman, 2004)

3.2 The External perspective

The external perspective regards the context and environment which the firm operates. For example, the regulatory environment, economic conditions, the availability of related and complementary technologies, the presence of an entrepreneurial culture and financial systems can all affect the success of disruptive innovations (Yu & Hang, 2010). However, as large global firms operate in multiple countries and markets it is difficult to isolate any effects sustained from the external environment as their external environment differs between various countries and contexts. Therefore, this paper will not include any analysis from the external perspective.

3.3 The Customer and Marketing perspective

Even though companies detect the emergence of new disruptive innovations, they might still fail to manage them as they might be missing the link between the new innovation and how it will change the marketplace or consumer behavior, thus, to prevent this firms should focus on what is happening with customers and operational needs (Paap & Katz, 2004). Similarly, a positive relationship between higher emerging customer orientation and the development of disruptive innovations have been found by Govindarajan and Kopalle (2004). On the other hand, it is also argued that many firms indeed understand emerging customers' needs and are not too focused on existing customers, but, they lack the resources and competencies to respond to disruptive innovations (Henderson, 2006). Nevertheless, it is important to understand customers' latent needs and finding emerging market opportunities (Christensen & Bower, 1996)

3.4 The Technological perspective

Kostoff et al. (2004) stress the need of having a systematic way to identify or create potential disruptive innovations. They propose a clear-cut technology roadmap; however, it could be argued that an over detailed roadmap can in fact be counterproductive as disruptive innovations are discontinuous (Yu & Hang, 2010). The technological perspective has received little attention to date and the explicit identification of R&D strategies specific to the creation of disruptive innovations has remained futile (ibid). Nonetheless, technology road-mapping for the creation of new disruptions or strategically and systematically scanning the landscape to identify new disruptive opportunities for existing technology or products might be a way to enable the success of disruptive innovations.

4. Methodology

This chapter describes the methodology of the thesis. Starting with an explanation of using a single case study, followed by a discussion around the case selection and data collection and ending with a brief account of the operationalization used for the thesis.

4.1 Case study as research design

To address the research question with regards to the time and resources available for this study a single case study was chosen. An in-depth case study of one established firm that has managed both sustaining and disruptive innovations can help to identify and explore key aspects of how large global incumbents manage innovation over time and overcome the innovators dilemma. A single case study allows for an extensive examination of one case (Bryman, 2008). Nevertheless, there are also limitations to consider, for example, the difficulties of generalizing findings from a single case study; due to the study only concerning one out of many cases, findings provide an extensive examination of one single case instead of generating generalizable findings (Bryman, 2008). Because findings cannot be generalized it affects the study's external validity (ibid). However, this study does not aim to provide generalizable answers, but aiming to explore central features that later can be further researched and tested with the aim of finding generalizable answers. While the study is motivated by the broad question of how large global firms successfully innovate and manage disruptive innovations, it is empirically restricted to the case of 3M. Consequently, it is difficult to isolate the findings and effects of 3M's innovation management; hence, findings from this study cannot prove that they are certainly caused by 3M. Findings can only provide indications of possible causalities, lowering the study's internal validity. All the same, a single case study provides opportunities to investigate in-depth how an established firm like 3M have stayed innovative and managed disruptive innovations, generating a good starting point for future research, which can investigate derived findings to see if they hold true in other cases. This research provides the necessary foundation for further empirical research in the field of disruptive innovations.

4.2 Case selection

As previous literature has shown, it is not common for large firms to survive during many decades and especially not to stay strong and dominant in the industry. Hence, it is vital to choose a case consisting of a firm that has managed to survive for a longer time period. According to a study by Wiggins and Ruefli less than 0.5 percent of the companies in their sample stayed in the top quartile for more than 20 years (cited in Beinhocker, 2006). 3M was one of three companies (or 0.04 percent of the sample) that managed to stay at the top for 50 years (ibid). 3M was founded in 1902 and has thus managed to survive for 115 years, suggesting that they might be a good case to investigate.

Moreover, 3M has been awarded the United States government's highest award for innovation, the National Medal of Technology (Govindarajan & Srinivas, 2013), they have been termed one of the

top ten most innovative companies in the world at a third place by Strategy and Price Waterhouse Coopers in 2016 and there is a long list of innovation awards that 3M has been awarded during their lifetime (www.3m.com). Wentz (2008) even call 3M an “Innovation machine”, indicating that 3M might be a suitable case to study with regards to successful innovation management.

Furthermore, when it comes more specifically to disruptive innovations, 3M has been at the forefront of the innovation frontier. For example, 3M’s innovations in the field of nonwovens (high-tech, engineered fabrics made from fibers) have revolutionized manufacture of every day products such as air filters, medical bandages and kitchen scrubbers and new applications are still coming. 3M’s famous Post-it notes and Scotch tape are also examples of breakthrough innovations that could be seen as disruptive as they both created new markets addressing non-consumers. Additionally, 3M’s history of change might also indicate that they have been disrupted from new technologies, innovations and competitors. Therefore, 3M could be an appropriate case to study with regards to their management of disruptive innovations and the innovators dilemma.

4.3 Data collection

To acquire insight on how 3M manages innovation, secondary data consisting of a book (A century of innovation. The 3M story) published by 3M in relation to their 100th anniversary (3M, 2002) was used. The data consists of a compilation of 3M voices, memories, facts and experiments from 3M’s first 100 years and more than 250 employees, retirees, customers, board members, journalists, business scholars and other observers of 3M were interviewed for this book (ibid). Most of the data collected for this thesis from this source consists of citations stated in the book, complemented by some facts. The analysis of the raw data is made exclusively for this thesis. This source provides rich data covering 100 years of 3M’s 115 years enabling a longitudinal perspective of 3M’s innovation management. Having data that spans over many years is vital as innovation, especially disruptive innovation can require many years to reach its potential (Christensen, 1997; Gilbert, 2003). Complementing data such as 3M’s annual reports, website, press releases and articles and previous research on 3M has also been used to gain a more comprehensive view of their innovation management over the course of 3M’s lifetime. Using 3M’s book, annual reports, website and press releases is limiting in the sense that they are all produced by 3M; hence, the data might be biased, e.g. in that 3M might want to portray themselves as innovative and successful. Therefore, 3M might emphasize their successes in the area and downplay possible drawbacks that they have experienced. Yet, as the material is publicly available it increases the data’s trustworthiness since they are subjected to public scrutiny.

Moreover, to gain more in-depth insight on how 3M manage innovation today, primary data was collected through an interview with Pontus Broddner, Technical Manager Nordic Region at 3M. As head of the 3M Nordics R&D organization and a member of 3M’s Nordic management team, Broddner has great insight into 3M’s innovation management and he can provide insight on senior management at 3M. The interview was conducted in a semi-structured manner with an interview guide presented in table 1. The interview was recorded and took approximately 70 minutes. The

semi-structured interview method is useful since it allows for probing and flexibility and the interviewee has the freedom to expand on given questions; likewise, the interviewer is also allowed room to pursue interesting topics that arise during the interview (Bryman, 2008). Nevertheless, there are limitations that may perhaps affect the results from the interview e.g. the interviewee might have been affected by the interviewer or the recorder and he might also have answered the questions to be perceived as socially desirable which could result in faulty unreliable answers. In addition, as Broddner represents 3M, he might give biased answers favored towards 3M. However, the aim of the research was not revealed to the interviewee until after the interview to avoid answers being tailored for the research aim. The issues of social desirability, bias and the interviewer effect are difficult to counteract, but to nuance the data it has been somewhat cross-checked by additional data sources and methods. Triangulation of multiple methods and sources of data has been applied by using a mixture of primary and secondary sources and a combination of interviews, public records and articles from different time periods. Ideally more interviews should have been conducted to provide a more compelling and diversified view of 3M's innovation management, however, due to difficulties in arranging interviews during the time constraint on this thesis more interviews were not possible. Nonetheless, the data collected for this thesis can still count as sufficient for the purpose of exploring 3M's innovation management.

4.4 Operationalization

Generally, qualitative data results in the accumulation of large volumes of information and qualitative data analysis is not governed by codified rules in the same way as quantitative data analysis (Bryman, 2008). Hence, an operationalization has been constructed to define ways to measure the concepts of innovation and disruptive innovation management (see table 1). As innovation is difficult to directly measure, it requires to be measured by other indications and dimensions, hence, an operationalization of the concepts mentioned in Yu and Hang's (2010) article have been operationalized into more manageable and measurable dimensions. In addition, the interview guide has been constructed along with the operationalization.

5. Empirical data

The following chapter begins with introducing the case of 3M Corporation, outlining some essential background information to help better understand the case and their approach towards managing innovation over time and disruptive innovation. Subsequently, presenting the empirical data found under each of the three different perspectives: Internal, Customer and Technological perspective.

5.1 Case introduction of 3M

Minnesota Mining and Manufacturing (3M) started off as a mining company in 1902 with the goal to harvest the mineral corundum from Crystal Bay. The mine did not produce much corundum so the firm turned to producing sandpaper products followed by other materials and products as well. A sandpaper factory was built in St. Paul in 1910, and since 1916 3M's headquarters is also placed in St. Paul. Slowly 3M started to grow and through innovation and perseverance they grew into the successful, global company that it is today. By 1952, 3M had established 3M International, surpassed the US \$100 million mark and employed some 10,000 people. By 1977, the company had grown to some 80,000 employees spread across 40 countries with net sales of US \$3.5 billion. Today in 2017, 3M is a diversified global manufacturer, technology innovator and marketer of a wide variety of products and services. They manufacture over 60,000 products that are sold in more than 200 countries, over US \$30 billion in sales and 90,000 employees in 70 countries. In 2014, 3M earned their 100,000th patent and today they hold some 109,000+ patents. (www.3m.com)

Furthermore, 3M is currently divided into five business groups: Industrial; Safety and Graphics; Health Care; Electronics and Energy; and Consumer. Some of their major products include adhesives, laminates, fire protection products, medical and surgical supplies, dental products, office supplies, optical film, and car care products. Some of 3M's most recognizable brands include Scotch Tape, Post-It notes, ACE bandages, Nexcare and Thinsulate insulation products. Through 3M's Corporate Research Laboratories, they have identified 46 technology platforms that are broadly classified into four categories: Materials; Processing; Capabilities and Applications (see Figure 2). In 2015, 33 percent of 3M's sales came from products which had been launched during the prior five years and they spent \$3 billion in R&D and capital expenditure (Annual Report, 2015). In addition, 3M have throughout their lifetime aimed to invest 7 percent of their revenues to R&D, through good and bad times.

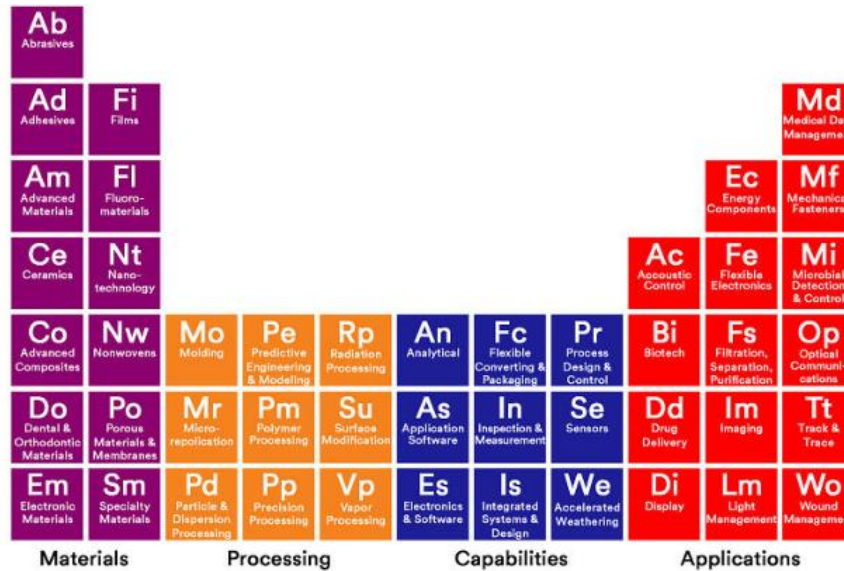


Figure 2. 3M technology platforms

Source: http://www.3m.com/3M/en_US/company-us/about-3m/technologies/

5.2 The Internal perspective

5.2.1 Human Resources

According to Broddner, there is a team at the corporate level at 3M who are responsible for disruptive innovations, not in the sense of looking for innovations or changes in the landscape that can threaten 3M’s business but rather with a possibility perspective and there is a centralized innovation platform seeking tendencies for what will happen in the future. 3M also state “We want to be the first to make our own best products obsolete; that way, it’s difficult for the competition to catch up.” (3M, 2002: 120). However, at 3M senior and middle management are neither educated in what disruptive innovations are and how they can manage them nor are they encouraged in particular to focus on disruptive innovations (Broddner). But leaders at 3M are known for their ability to think and act as entrepreneurs (3M, 2002: 235) and leaders are selected based on passion not seniority (ibid: 174). Regarding, incentives for senior and middle management, Broddner considers them more short-term than long-term. As Broddner puts it: “we are on a quarterly business cycle”, yet he also stresses that: “at 3M we are constantly reminded of the long-term perspective, we are one out of 7 companies that are still alive from the Dow 30 list”. He continues by saying that 3M has identified that they might be too short sighted. Moreover, 3M stress that they have the patience to wait for profitability (3M, 2002: 156) and as Coyne puts it: “At 3M, we try to balance the pressure for near-term results against this understanding of the nature of innovation. We know that long-term sales growth and sustainable profits can only come from keeping one eye on the path directly ahead and one eye on the horizon.” (2001: 1). Correspondingly, Govindarajan and Srinivas (2013), argue that 3M’s critical balance between short and long-term concerns include mechanisms such as the Thirty Percent Rule, which means that 30% of each division’s revenues

must come from products introduced in the last four years, something that is rigorously tracked and employee bonuses are based on successful accomplishment of this goal.

Regarding ownership, Walter Meyes retired vice president, Marketing (3M, 2002: 6) state that: *“The founders had unshakable faith in the future of 3M. Even though they almost went bankrupt they kept pouring money in. You succeed if you have faith”*. Apart from this statement, the founders are not mentioned more than to explain how 3M was founded. However, William McKnight, President 1929–1949, Chairman of the board 1949–1966, is extensively mentioned, being exact, he is mentioned 226 times in 3M’s book (3M, 2002). McKnight is also commonly cited by others for his contribution for innovation at 3M and for his belief in entrepreneurial people, 3M’s divide and grow strategy, setting up core values of innovation and implementing the 15 % culture (e.g. Coyne, 2001; Nicholson, 1998; Westland, 2008; Grundling, 2000; Govindarajan & Srinivas, 2013). For example, McKnight states: *“the first principle is the promotion of entrepreneurship and insistence upon freedom in the workplace to pursue innovative ideas.”* (...) *“The best and hardest work is done,”* he said, *“in the spirit of adventure and challenge . . . Mistakes will be made.”* McKnight put his faith in the good judgment of 3M employees. He warned against micromanagement and the chilling effect that accompanies intolerance of failure. *“Management that is destructively critical when mistakes are made can kill initiative,”* he said. *“It’s essential that we have many people with initiative if we are to continue to grow.”* McKnight knew that others could rise to leadership. *“As our business grows,”* McKnight said in 1944, *“it becomes increasingly necessary to delegate responsibility and to encourage men and women to exercise their initiative.”* (...) *Delegating responsibility and authority, he said, “requires considerable tolerance because good people . . . are going to want to do their jobs in their own way.”* (3M, 2002: 9). Today, 3M is neither managed by the founder nor by McKnight, but Broddner state that: *“Our CEO Inge Thulin is very good at setting the internal direction.”*

According to Broddner, employees that are not directly involved with product development, R&D or work with the technologies do not often have direct contact with the markets and with others that use or work with their technologies/products. But for those working with the technologies in the product development labs there are processes for market and customer contact, however, these processes usually come at a later stage. First off, all projects at 3M go through a stage-gate process (The bob cooper model Stage-Gate® process) and a so called New Product process (NP process) where market intelligence and voice-of-customer is mandatory components. Evaluation routines do not differ depending on the project or innovation. (Broddner)

Regarding the entrepreneurial culture at 3M, they were one of the first companies to start with a 15 percent culture where employees are given the freedom to spend 15 percent of their working time to innovate and work with projects they are passionate about (Broddner; Hill & Jones, 2008). According to Broddner, 3M is one of the few companies that have actually got the 15 percent culture to work: *“It is important that it does not become a stick but rather an elective carrot”*. And

as Dale Dauten puts it: “*The beauty of 3M’s 15 percent rule is that it’s not a rule at all: it’s permission*” (3M, 2002: 34). Broddner explains that 3M strongly enforces that managers are not allowed to steer these projects; they are so called “hands off” for managers. Additionally, these projects do not demand any requirements but can consist of any ideas. Once a project starts to become something it is possible to apply for special scholarships that exist only for this type of innovations. When ideas start seeking scholarships they also start becoming visible around the firm so that others can give input, collaborations can be formed and maybe discover usability for the innovation at 3M. Once usability or compatibility for 3M has been discovered the innovation gets integrated into the traditional development process. The whole idea with the 15 percent culture is to give employees freedom to explore and work with projects they believe in. Moreover, there is a special scholarship that only is given to projects that have been rejected by the business side, thus, it is possible to get scholarships even for non-traditional and unique innovations that in the beginning might not seem to have any connection to 3M’s portfolio. An example of how the 15 percent culture can work is portrayed by Govindarajan and Srinivas (2013) by the engineer Richard Drew who worked with the Wetordry sandpaper and noticed that the painter was not able to mask one section of a two-tone car while painting the other, thus he started working on a solution for the problem. After two years’ senior management ordered him to get back to work on the waterproof Wetordry sandpaper. Drew followed the directives, but continued working on the tape project on his own time which eventually resulted in Scotch tape.

To ensure this culture of innovation alive in spite of 3M’s global proportions, 3M state four important key ingredients that they follow: (1) attracting and retaining imaginative and productive people, (2) creating a challenging environment, (3) designing an organization that doesn’t get in peoples’ way, and (4) offering rewards that nourish both self-esteem and personal bank accounts (3M, 2002: 32). Moreover, 3M tend to not focus too much on education when hiring new employees as it can make people ridged and reduce their ability to “think outside the box” (3M, 2002: 27). 3M also look for evidence of creativity in past experiences and search for people who can demonstrate that they can go beyond theory to build new things (Christiansen, 2000: 142). Additionally, 3M has actively worked to create intrapreneurship i.e. internal entrepreneurship within the firm e.g. “*To help accomplish this, Lehr asked Gary Pint, then group vice president, Electrical Products Group, to chair the effort. “Gary created subgroups in manufacturing, in our sales offices, in our plants,” said Lehr. “He asked them all to develop guidelines for internal entrepreneurship and to determine how people should be recognized for being entrepreneurs inside the company. It was an awareness program designed to make people understand that even if they came from the tax department or the fire department, there was always room for doing things a better way.*” (3M, 2002: 229). Simultaneously, 3M also hired Gifford Pinchot, a well-known management consultant and author of the book “*Intrapreneurship*,” to do his own assessment of 3M’s intrapreneurship quotient (ibid).

Apart from the 15 percent culture, 3M has a culture of being business ambitious, providing large freedom, being innovative and having a culture of collaboration (Broddner). In addition, many

describe 3M employees as being entrepreneurial, innovative and risk-taking (Dess & Lumpkin, 2005; Wankel, 2007; Morris et al., 2010). With regards to the risk-taking aspect, the answer is twofold according to Broddner; as a company, 3M only takes carefully calculated risks and he would not describe them as being prone to taking risks, however, it is true that at 3M, risks on individual level is encouraged, *“At 3M there are no failures, just unexpected results”* (Broddner) and *“It’s easier to ask forgiveness than permission”* (3M, 2002: 24).

Moreover, the famous innovation of Post-It notes came from the culture of failure (Broddner; 3M, 2002). At first in 1968 Spencer Silver, retired corporate scientist, Office Supplies Division, discovered a special adhesive that acted different from usual adhesives. Silver went around 3M trying to find usability for his new invention but did not find any. Five years after Silver’s initial discovery, Art Fry, retired corporate scientist, Office Supplies Division, was warming his vocal chords while sitting in the choir. Frustration rose as Fry turned to a hymn and his scrap paper bookmark fell to the floor. This made Fry think about Silvers adhesive, if he only could coat it on paper, that might create a better bookmark. Fry started working immediately, and explored the possibilities with the new adhesives and when he used these ‘bookmarks’ to write messages to his boss, he suddenly understood the idea. The idea was not bookmarks at all, but notes. Fry encountered serious technical problems very early and his boss, Bob Molenda, encouraged him to takes things one step at a time. First, there was the problem of getting the adhesive to stay in place on the note instead of transferring to other surfaces. Although 3M was known for its coating expertise, the company did not have coating equipment that was precise on an imprecise backing such as paper. It was difficult to maintain a consistent range of adhesion. *“All of these things bothered our production people,”* Fry said, *“but I was delighted by the problems. If there is anything that 3M loves, it’s to create a product that is easy for the customer to use but hard for competitors to make.”* Fry used his 15 % time to find manufacturing and technical solutions over about 18 months, and Molenda helped Fry find the time and money to dedicate to his pet project. A few years later the success of post-it notes was a fact. (3M, 2002: 39)

Furthermore, when it comes to outside expertise in the phase of innovation, 3M is very hesitant to involve other experts as they want to ensure the right to owning the intellectual property rights themselves and difficulties can arise if all of the papers are not in order etc. (Broddner). However, regarding inside expertise 3M state: *“Innovation has thrived at 3M because people talk. They strike up lively conversations in hallways, cafeterias and labs. They talk across departments and divisions. They meet to share ideas in brainstorming sessions and forums. While more traditional organizations have kept researchers and engineers within their own areas or divisions, where their loyalties were strongest, 3M has instead fostered a strong sense of attachment to the company as a whole.”* (2002: 32) Additionally, as Joe Bailey, vice president, R&D, puts it: *“The environment was unmistakable. I discovered that the technologies belonged to the company not the business units. Rather than protecting what they knew, 3M employees shared knowledge. I saw openness and a spirit of immense cooperation that helped people get things done. I soon learned that the most successful people at 3M were good at getting out of their offices, meeting people, interacting*

and knowing where to find the expertise they needed.” (3M, 2002: 32) Moreover, as Sumita Mitra 3M corporate scientist, state: *“The climate of sharing and openness is unusual here. I discovered that in talking to colleagues in other companies,”* (3M, 2002: 31). Additionally, 3M has implemented information technology (IT) that promotes knowledge sharing between business units to facilitate identification of new opportunities (Hill & Jones, 2008).

5.2.2 Organizational culture

Regarding organizational change at 3M, it is stated in the last annual report: *“Since 2012, in fact, we have realigned from six business groups to five, and from 40 businesses to 26.”* (2015: 2). Additionally, Broddner states that today they have changed to 24 businesses. Broddner continues with: *“At 3M, we have to work with change management because we constantly conduct so many changes. At the moment, we are conducting a modernization project where we are centralizing more into big global hubs, we have re-done our supply chain and our internal structure with Enterprise Resource Programs, additionally, we are implementing change programs aimed at changing our work processes”*. Moreover, these changes have gone relatively smooth, but they have been energy consuming as it is always difficult with change. Therefore, a lot of resources, such as personnel and focus has been put into change management to facilitate a smooth implementation. Additionally, *“Many say the company’s success over the years is linked to its ability to change as 3M, its products and the world marketplace evolves. In fact, when the company greeted the new century in 2000, more than half the businesses that were 3M staples 20 years before had disappeared from the corporate portfolio.”* (3M, 2002: 199). In addition, Coyne senior vice president, R&D, describes: *“3M expects to continue to change, enter new business space, and provide sustainable, profitable growth for decades to come.”* (2001: 1)

With regards to flexibility in the culture at 3M: *“Employees and observers of the company repeat like a mantra: minimal hierarchy, intentional informality, strong support for creativity and innovation. People are trusted to make the right decisions on their own and they’re rewarded for taking initiative. The most effective leaders within 3M understand the value of teamwork, they promote openness and cooperation, and they actively share information and knowledge. Remarkably, whether a 3M employee is based in any country around the world, they share the same values with their colleagues’ oceans away.”* (3M, 2002: 193). There is a shared belief system at 3M, combined with cultural diversity (ibid). Ken Schoen retired executive vice president, 3M Information and Imaging Technologies Sector, state that: *“We’ve blended many cultures with our 3M philosophy of doing business. In the end, everyone around the world says, ‘I’m a 3Mer.’”* (3M, 2002: 158).

Broddner also puts it: *“At 3M freedom meets focus”*, meaning that employees have their 15 % to allocate as they wish but through e.g. stage-gate processes 3M can ensure that there are structures in place to facilitate collaboration and usability. Moreover, McGrill and Slocum (1993) argue that 3M has shown that their advantage is their capacity to learn and unlearn. According to Basadur

and Gelade (2006), 3M establish strategic goals for inducing adaptability and flexibility by e.g. their goal that 30% of the company's products must be new every five years.

At 3M there are many different reward and recognition programs aimed at encouraging innovation and entrepreneurship e.g. Inventor Recognition Program, Technical Information Exchange , Engineering Achievement Award of Excellence, Alpha Grants for innovation in administrative, marketing and non-technical areas, The Technical Circle of Excellence and Innovation and to recognize manufacturing breakthroughs, Corporate Quality Achievements, The Process Technology Awards, The Genesis Program, The Carlton Society, Pathfinder Program and Innovation Stories. And as 3M puts it: *"Innovation thrives on personal recognition matched with financial support"* (3M, 2002: 41)

5.2.3 Resource Allocation

Concerning structured routines at 3M, they use the same stage-gate process and evaluation routine for all projects and innovations (Broddner); but, there is more than one way to identify and launch new products at 3M (3M, 2002: 26) and there is an open mentality at 3M: *"Every idea evolved should have a chance to prove its worth. This is true for two reasons: 1. If it is good, we want it; 2. If it is not good, we will have purchased our insurance and peace of mind when we have proved it impractical. Research in business pays."* (3M, 2002: 17). Additionally, as Art Fry puts it: *"At 3M we're a bunch of ideas. We never throw an idea away because you never know when someone else may need it"* (3M, 2002: 38) In addition, they emphasize financial measurements when evaluating projects and progress and every new product have to have a 30 percent operating income with specific growth targets (3M, 2002: 31) and in almost every case, a product or business is shed when it no longer meets the rigorous financial expectations of annual sales growth and profit targets (ibid: 200). Nevertheless, 3M also believes in long-term investments, a phenomenon they call "patient money", which Philip Palmquist retired technical director, Reflective Products Division, explains as: *"Scotchlite sheeting didn't show much profit for nearly 10 years. The same was true for fluorochemicals and duplicating products. It takes 'patient money' to make some ideas succeed."* (3M, 2002: 78). Accordingly, Harry Hammerly retired executive vice president, International Operations, formerly vice president, Finance state that: *"In the early stages of a new product or technology, it shouldn't be overly managed. If we start asking for business plans too early and insist on tight financial evaluations, we'll kill an idea or surely slow it down."* (ibid). Also, according to Govindarajan and Srinivas (2013), 3M's critical balance between present and future concerns, avoiding following only quarterly results, 3M use mechanisms such as the Thirty Percent Rule, and a three-tiered research structure, meaning that Business Unit Laboratories focus on specific markets, with near-term products; Sector Laboratories, on applications with 3 to 10 year time horizons; and Corporate Laboratories, on basic research with a time horizon of as long as 20 years.

3M also has a special side program or fast track called i3 – invest in innovation where all business units can come with suggestions for innovations that need this fast track (Broddner). The purpose of the program being to ensure that these types of innovation do not get stuck in the system but rather can fast track on the side of the regular system. Furthermore, in 1984 3M started the Genesis Program to optimize the innovative spirit at 3M by funding projects that has not yet qualified for 3M budget support through regular channels (3M, 2002: 41), the money is allocated to projects “no sensible, conventional person in the company would give money,” according to Chris Holmes (Gunther, 2010). One example of a project that received the Genesis grant was a new technology platform based on multilayered film. It began as tape backings, evolved to substrates for signs and in safety films for window glass and later on into reflective polarizers which later advanced into brightness enhancement films for e.g. TVs and smartphones (3M, 2002: 42-43).

Moreover, Moe Nozari executive vice president, Consumer and Office Markets, state: *“I had never seen this much diversity in research and applied science in one building. The atmosphere was electric. What we knew we shared, because technology at 3M doesn’t have owners”* (3M, 2002: 31). Even though as 3M puts it: *“Some worried that a new tape dispenser would “cannibalize” the crown jewel of transparent tapes. Dispensed in the traditional “snail,” curved shape, the product had been around since the 1930s and its market share was high around the globe.”* (3M, 2002: 179) 3M invested in research to develop a new tape specialized for gift wrapping.

Regarding development programs, 3M aim to have 40% of development in innovations that either develop a new product to an existing market, takes an existing product and modifies it to a new emerging market or develops a completely new product and addressing a new market (Broddner). 3M has a tradition of “uninhibited research for uninhabited markets” (3M, 2002: 80, 180), and the philosophy means following technology wherever it leads, often into new product areas never imagined (ibid: 180). A prime example is 3M’s investment in fluorine chemistry back in the 1940s, not knowing how the technology would be applied or having a specific product in mind; 3M bought key fluorochemical patents and began to experiment. The compound became a successful Scotchgard fabric protector in 1956. Experimentation continued in fluoropolymer compositions called fluoroelastomers which later led to high tech applications for the military and aerospace (ibid).

In addition, Nonwovens started as a grand failure but ended in success after Al Boese, corporate scientist took some chances and fought a little. 3M Sasheen decorative ribbon and Lacelon ribbon created a new product and a new market (3M, 2002: 50-55). Additionally, Nonwovens Technology Platform vividly demonstrates how 3M follows technology wherever it leads, into areas never imagined when the technology was first developed. Starting with ribbon in the 1940s, hundreds of products using nonwoven technology have since been developed in almost every area of 3M (See figure 3).

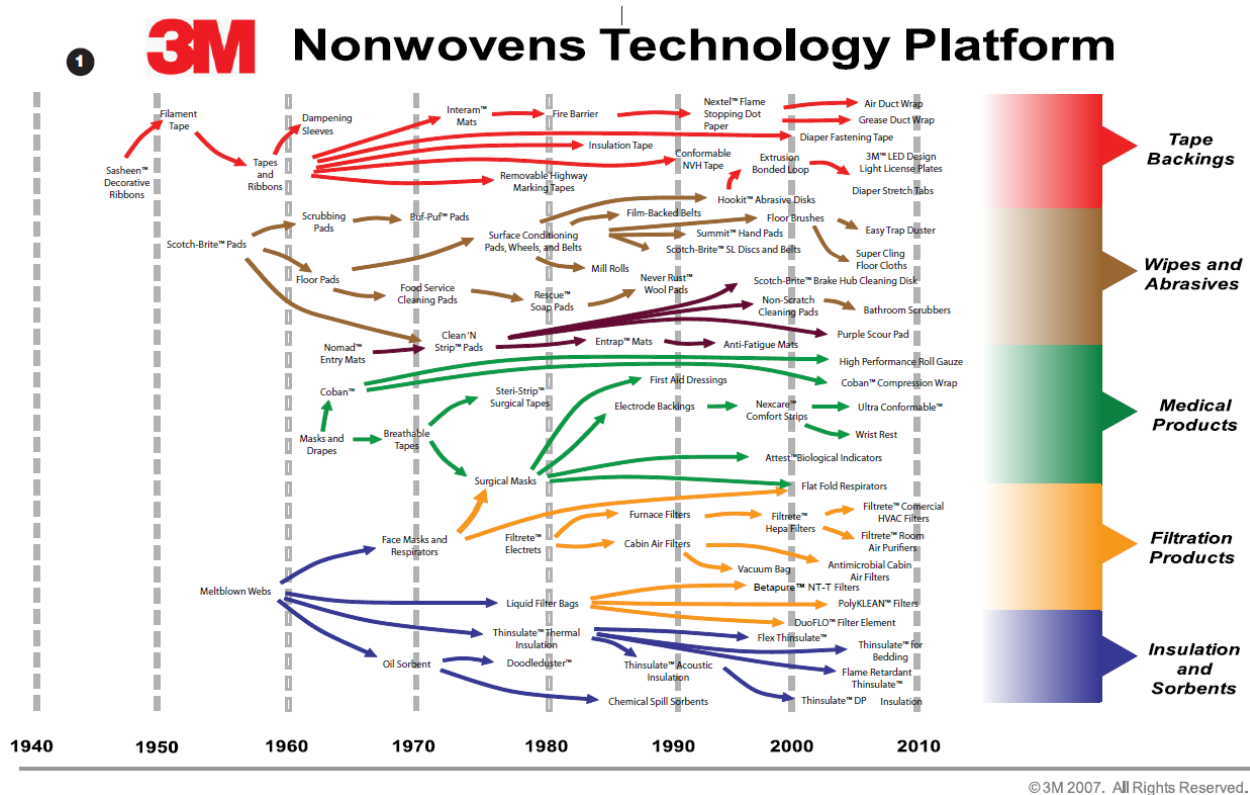


Figure 3. Timeline over 3M Nonwovens technology

Source: 3M, 2002: 180

5.2.4 Organizational structure

3M's organizational structure consists of 5 larger business groups and 24 sub divisions. The 5 business groups have individual profit centers that have the power, autonomy and resources to run independently (3M, 2002: 169). 3M have 100 profit centers, where each division operates like a small company and every division manager acts autonomously and is accountable for their own actions (Open Textbook Library, 2010). The aim was "to keep the divisions small and focused on satisfying customers and giving people a chance to be entrepreneurial," according to Dick Lidstad, retired 3M vice president, Human Resources, (ibid: 170), but with core functions remaining centralized e.g. engineering, HR, R&D and finance. There are no significantly smaller units and there is no real difference in their degree of autonomy, as Broddner puts it: "We have a pretty pervasive culture and structure at 3M". 3M operates with simultaneous "loose-tight" properties i.e. loose when entrepreneurial action matters and tight when corporate consistency is necessary (3M, 2002: 170). There are no business units that have complete autonomy (Broddner). 3M has an organic organizational structure which is flexible, decentralized and with low levels of formalization (Open Textbook Library, 2010), which is advantageous to entrepreneurial behavior and innovativeness (Burns & Stalker, 1961; Covin & Slevin, 1988). They have decentralized decision-making to team and divisional level (Deloitte, 2016; Volberda, 1999).

3M has implemented a philosophy called divide-and-grow which means that as a division grows, it reaches a size where it tends to spend too much time and effort on established products and markets and less time on new products and businesses, which is the time to spin-off the new business and give it new management (3M, 2002: 169). When the new business is separated, the established division needs to find new products and markets to meet its growth objectives to compensate for contributions from the business that became independent. Observers have called the phenomenon “renewal” (3M, 2002: 170). This strategy has been implemented to secure the agility and small-company atmosphere (Open Textbook Library, 2010) and it is 3M’s way to encourage spin-off projects (Volberda, 1999). This is also how 3M diversification began, as each small program was successful, it progressed in ever increasing sizes to: a project, a department and then a division. For example, Magnetic Recording Materials was spun off from the Electrical Products Division, and grew into its own division and then spawned a sequence of divisions. A copying machine project for Thermo-Fax copiers grew to become the Office Equipment Division. A new venture in printing products turned into several divisions that became the Graphic Arts Group. The Occupational Health and Environmental Safety Division was a spin-off from the Retail Tape Division. Personal Care Products stepped out from the Tape Group. 3M’s huge Reflective Products Division eventually was divided into four separate divisions. (3M, 2002: 170)

Moreover, the main underlying reason for 3M acquisitions are the technologies, specifically technologies that 3M can commercialize but also for the purpose of learning more about a specific technology e.g. Cogent and FS tech, according to Broddner. An example of such a strategic acquisition is 3M’s biochemical/pharmaceutical research: After 3M had invested in a biochemical research lab, 3M wanted to grow in pharmaceuticals through a strategic acquisition and as Lehr states: “*We knew we either would have to build the business ourselves or acquire it, ... “It was becoming more and more obvious that this would require a different mentality ... Along with a different mentality, we needed a sales force familiar with the market.”* (3M, 2002: 87) Hence, in 1970 Riker became a 3M subsidiary, which later on, in 1991 became fully merged into the company as 3M Pharmaceuticals division.

Furthermore, 3M also acquires companies with the aim to strengthening a core business, some of these acquisitions have succeeded, while others failed to yield the expected product synergy or financial returns. For example, 3M acquired National Outdoor Advertising (National Ad) in 1947, confident that billboards would be natural venues for miles of Scotchlite reflective sheeting. Years later, even though National Ad made strong revenues, the real goal to produce strong product synergies did not happen, so, in 1997, 3M sold the business. But, observers have criticized the amount of time 3M takes to make decisions about exiting a business e.g. they kept National Ad in the loop for nearly 50 years (3M, 2002: 200-201). Moreover, as 3M puts it: “*In many cases, even though a business is exited, it leaves behind technological know-how that is valuable years later.*” (3M, 2002: 200); additionally, as L.D. DeSimone stress: “*3M has an organic, living nature. Pruning is the natural, though difficult part of continuous revitalization. Meanwhile, new technology platforms become the seeds of future growth.*” (ibid).

In 2015 3M signed strategic agreements with Impel to “*accelerate commercialization and cost effectiveness of POD technology platform and Impel’s growing portfolio of enhanced CNS products. (...) a strategic alliance aimed at advancing Impel’s revolutionary Precision Olfactory Delivery (POD) technology for the enhanced Central Nervous System (CNS) delivery of drug products. (...) The alliance with 3M will enable Impel to expedite the development and commercialization of the POD technology and accelerate Impel’s internal pipeline into late-stage clinical trials and subsequent global regulatory submissions. As part of the deal, 3M and Impel will collaborate on programs directed to the continued development and commercialization of POD technology.*” And as Cindy Kent, President and General Manager of 3M Drug Delivery Systems states: “*Impel’s POD technology provides an important solution to an unmet need in the drug delivery marketplace. We look forward to supporting Impel as they commercialize the POD technology and expand upon 3M’s leadership in developing novel approaches to major problems confronting the pharmaceutical and biotechnology industries.*” (3M, 2015)

In the search for ways to expand its customer base, 3M sought out the automotive industry and tried to grasp GM, Ford and Chrysler’s end-user requirements in order to develop products to meet those specific needs. Starting with a niche solution of automotive parts and a 5 percent market share in 1978, 3M’s market share grew to about 55 percent in the United States by the late 1980s. The division was a very small part of 3M’s chemical business and as Bob Brullo, product development engineer, puts it: “*We operated like a little, entrepreneurial company. We focused on offering innovative technologies and a very fast response time to our customers. We had a tremendous amount of freedom to do what we had to do. We also knew how to circumvent the bureaucracy when we had to.*” “*Sid Leahy was our group vice president,*” Brullo said. “*He urged us to start building alliances outside the company that could lead to co-development projects.*” “*Experimentation followed with several alliances; some worked, others didn’t. There were lessons learned, but out of these relationships came technology and product gains and the recognition that 3M should team up with a “big player” to leverage its applications know-how and technological expertise to the broader fluoropolymer industry.*” (3M, 2002: 181)

Another strategic alliance from 3M’s history is 3M’s partnership with German chemical giant Hoechst A.G, resulting in the joint venture, Dyneon L.L.C. Brullo explains the partnership as: “*The combination of Hoechst’s manufacturing capabilities and 3M’s applications and marketing expertise means we’ll be able to bring products to market faster than ever before,*” (3M, 2002: 182). In 1998, an additional joint venture, called Alventia L.L.C., was formed with the Belgian chemical giant Solvay A.A., allowing a key 3M raw materials plant to use Solvay’s proprietary technology resulting in a cost-effective product available to both companies (ibid).

Spin-offs for the sake of keeping ownership is not a common strategy at 3M, however, they do divestments when they see that others can do it better than 3M e.g. they divested their library systems due to too low margins (Broddner). Yet, there are a few examples throughout 3M’s history of a proper spin-off. For example, in 1995, 3M spun-off their data-storage and imaging systems

business creating the new and completely autonomous company called Imation (today called Glassbridge Enterprises) in Oakdale, Minnesota, near 3M headquarters (3M, 2002: 201). It was a “homegrown” business, mainly created and commercialized within 3M, involving products based on pioneering technologies, which not only changed the basis of competition; but also created new global industries. Moreover, the business was highly profitable for decades, and represented a significant share of 3M’s total annual revenues. (ibid). As Charlton Dietz describes it: *“We had superior technology. We made magnetic media better than anyone else in the world, including the Japanese, but they were willing to accept a lesser profit. We thought we could be better technologically. Ultimately, we thought we could win. This drove the decision to spin off the business. We knew the new company (later called Imation) would have the best technology in the world.”* (3M, 2002: 209).

3M have one big internal forum called The 3M Global Tech Forum which was created in 1951, a forum where everyone from 3M that works with technology can join (3M, 2002: 32). It is a voluntary informal network for employees to share knowledge and all managers allocate budget to the forum to cover events, fairs, travels etc. The original goals were to foster idea sharing, discussion and inquiry among members of the 3M technical community, while simultaneously educating technical employees (ibid). The forum is described by Broddner as a *“grassroots activity/movement”*. As Marlyce Paulson state: *“The forum pulls them from across 3M to share what they know. It is a simple but amazingly effective way to bring like minds together.”* (3M, 2002: 33). Moreover, James Hendricks stress: *“The forum has not been bound by any set of rules but has been allowed to develop naturally.”* (3M, 2002: 34). The Global Tech Forum has also been expanded into a Marketing Forum, so the business experts also have the same mechanism (Schiff, 2016). Another forum is their global web based forum called InnovationLive where 3M invites all of its sales, marketing, and R&D employees to together collaborate, share knowledge and identify new future markets with high revenue potential (Gast & Zanini, 2012).

Another internal forum is The Carlton Society which was created to explore a broader research horizon including pure and fundamental research (3M, 2002: 17). 3M describes the society as: *“Analytical chemists, physicists, biologists – all working together to pursue scientific solutions to life’s challenges”* (www.3m.com). The Carlton Society, still recognizes 3M technical employees for career achievements: *“The Carlton Society really represents the best of the best of 3M’s community”* and it is even described as *“3M’s hall of fame”* (ibid). Guy Joly says: *“You have an opportunity to work across disciplines and collaborate with people with expertise outside your area of expertise”* and Matt Scholz also state: *“The people that are part of the Carlton Society are actively mentoring other people. It’s all about giving back”* (ibid)

3M also participate in external forums such as The Innovation Roundtable which is a global network exclusively for innovation executives in multinational firms that facilitates connections between innovation managers in a setting where they can learn about best practices from executive speakers, discuss selected innovation topics, and share experiences with peers. Additionally, at 3M

the slogan “*collaborate early and often*” is widespread (3M, 2002: 65) and collaboration is commonly mentioned as part of the 3M culture (Broddner). 3M also has several official pathways to support organizational communications, learning and knowledge management through e.g. Formal Learning Networks, Intranet Knowledge Platforms Databases, Best Practice Descriptions/Processes, Company Education Facility and Idea Sharing (www.3M.com). Moreover, as Michele Whyte, Director of Global Sustainability at 3M puts it: “*there is something really special about 3M when I think of collaboration, that I don’t think happens as robustly in other companies. It’s our culture. We’re a heavily matrixed organization, we don’t have layers. And we have to function that way in order to do anything.*” (cited in Schiff, 2016). On their website 3M state: “*The 3M team doesn’t keep collaboration in-house. Let’s talk about the design you want to achieve, or the issue you’re trying to overcome, and together we’re more likely to come up with a solution that works. How does this happen? First, we’ll assign an applications engineer to you. That person will assemble a team to help develop a solution that suits your needs. It may take time, but we’ll work to come up with a solution that can be manufactured, tested, and eventually scaled-up for full implementation.*” (www.3m.com).

5.3. The Customer perspective

With regards to 3M’s search for new and emerging markets, Broddner mentions that first megatrends are identified from one global, centralized unit and then the 24 different divisions relate to these megatrends e.g. through technology road maps. As Jon Lindekugel, Senior Vice President at 3M Business Development state: “*Megatrends serve as our starting point to create insights and foresights on new and evolving markets at the intersection of these trends, technologies that enable innovation in these new markets and business models that can grow and adapt to the changing global environments*” (3M, 2015a). Examples of megatrends identified by 3M (2015a) are: (1) Reimagining Natural Resources, (2) Shifting Demographics, (3) Expanding Digital Economy and (4) Evolving Economic Landscape. Every megatrend is explained in detail with multiple sub-trends. Broddner explains that it is on the divisional, decentralized level that the actual strategies are made. They decide themselves which customers to engage further with. In addition, 3M has a side track program called i3 – Invest in innovation where the different business groups can give suggestions for innovations that need a fast track or growth program. Here is what Broddner identifies as a path for disruptive innovations because this route goes outside the regular system to avoid getting stuck in the process/bureaucracy; this is a so-called technology push path.

In parallel, through 3M New Ventures (today called 3M Ventures), they study global megatrends to “*identify and invest in technologies and ideas that the company can adapt to bolster innovation and drive growth.*” (3M, 2011). Moreover, as Stephan Gabriel, president of 3M New Ventures explains: “*The world is changing so fast,*” “*We need to look far into the future, anticipate customer needs and move fast when we find the right opportunities.*” “*We think outside the box, assessing major trends and looking globally, across all industries, for innovative and fast-growing small to*

mid-sized companies. We're looking for fresh ideas, exciting concepts and new ways of working with customers." (ibid). The aim of 3M New Ventures is to identify likely future fields of business or technology that are new to 3M and invest in these companies and start-ups. They use an extensive innovation network and experts to identify and evaluate companies with enthusiastic, entrepreneurial management and consider how these might connect to 3M's strategic portfolio (3M, 2011). 3M Ventures is a venture capital arm of 3M with the purpose to: "*advance 3M innovation by creating growth options in areas of strategic interest through minority equity investments, leveraging the global entrepreneurial and venture community*". Upon what 3M Ventures do 3M state: "*We partner with entrepreneurs, start-ups and innovative companies in fields related to our strategic focus areas. Ideas can be at any stage from prototyping to late stage and our investment can range from seed funding to capital investment*". Similarly, Crunchbase (2016) state that: "*3M New Ventures was created to strengthen 3M's position at the leading edge of global innovation by complementing 3M's holistic innovation strategy with a focus on disruptive, early stage innovations outside of the company's existing portfolio. 3M New Ventures identifies and invests in the most promising new-to-3M technologies, services and business models with long term strategic relevance to 3M*".

Furthermore, 3M has the intention to invest 40% of all investment into class 4 and 5 innovations, e.g. innovations including a new product to an existing market, an existing product to a new market or a new product to a new market (Broddner).

With regards to customers' needs, 3M material embraces a preventive attitude. For example, 3M state that "*It's not up to 3M's customers to ask for products they need; it's up to the company to anticipate the needs customers don't even know they have and develop product solutions*." (3M, 2002: 47) and Moe Nozari executive Vice President, Consumer and Office Markets stated that: "*Our goal is to give people a product that's better than what they have today . . . or a brand new product they didn't know they needed*." (3M, 2002: 120). In addition, 3M state that that you should "*know your market well enough to anticipate your customers' wants and needs even before they do*" (3M, 2001: 125). According to Govindarajan and Srinivas (2013), 3M scientists go out into the field to observe customers in order to understand their pain points and customers to 3M can also visit Innovation Centers that are set up specifically with the purpose of exploring possibilities, solving problems, and generating product ideas.

In 1999, 3M started collaborating with United Hospitals in a program called Partnership in Patient Care where 3M employees meet with medical staff to gather feedback on existing products and prototypes in conferences and focus group panels (3M, 2002: 112). Originally created as a way for 3M technical employees to gain a closer understanding of the customer's environment, the program has been expanded to include anyone in the division. The goal is to understand medical staff and patient needs by learning together, sharing information about 3M technologies, and developing personal working relationships with staff.

Moreover, as Gary Pint (vice president, Telecom Systems Group) said: *“To start and build the Telecom business, we had to listen carefully to customers and be as responsive as possible”* (3M, 2002: 47) and according to John Benson (Executive vice president, Health Care Markets): *“We call it being ‘customer intimate.’ If we’re going to develop new and better products to help improve the practice of medicine and advance human health, we better be out there with the practitioners—the doctors, the nurses, the anesthesiologists.”* (3M, 2002: 113)

When the Office Supplies division expanded into ergonomics they were told to “think outside the box” so they looked outside their division to find 3M technologies. For example, the gel used in the wrist rests was first developed by 3M Health Care for other medical needs. To discover the latent needs, they videotaped employees at their work stations to understand how they worked and that is how they noticed that people were massaging their wrists without even thinking about it. (3M, 2002: 124) Moreover, it was important to have international involvement early hence the division set up videoconferences with 3M peers around the globe to review the product concept drawings.

Since 1996, 3M has used the lead user process as a systematic way of finding people and organizations on the cutting edge in order to create breakthrough innovations and identify new emerging markets (Von Hippel et al., 1999; Drew, 2006). Roger Lacey, head of the Telecom Systems Division explains 3M’s lead user process as: *“the method brings cross-functional teams into close working relationships with leading-edge customers and other sources of expertise.”* 3M considered the lead user process after Shor stated *“Our business unit has been going nowhere. We’re number one in the surgical drapes market, but we’re stagnating. We need to identify new customer needs. If we don’t bring in radically new ways of looking for products, management may have little choice but to sell off the business.”* (ibid). They started the project by learning more about the cause and prevention of infections by researching the literature and by interviewing experts in the field, followed by a workshop with management in which they discussed all that they had learned and set parameters for acceptable types of breakthrough products. In the early stage of the project the focus laid on understanding developed countries potential needs, but the more they learned they realized that there were even greater needs in developing countries, hence, they travelled to hospitals in Malaysia, Indonesia, Korea, and India to understand their needs better through numerous field operations. Subsequently, they set up workshops to investigate the thesis *“Can we find a revolutionary, low-cost approach to infection control?”* and after a while they ended up with concepts for six new product lines and a radical new general approach to infection control. One of the inventions involved entering a completely new market, from previously focusing solely on products designed to prevent surface infections to enter the market aimed at controlling blood-borne, urinary tract, and respiratory infections, however, this would require the division to change its strategy; which 3M management later on did.

5.4 The Technological perspective

David Powell, vice president of Marketing, emphasize the importance of R&D at 3M: *“Annual investment in R&D in good years— and bad— is a cornerstone of the company. The consistency in the bad years is particularly important.”* (3M, 2002: 18). In addition, they state on their website: *“R&D is the heartbeat of 3M. We invest about 5.8 percent of our sales back into the science that makes 3M strong. That investment helps produce more than 3,000 patents each year and a steady stream of unique products for customers.”* (www.3m.com). In the latest annual report (2015) it is stated that: *“3M continued to support its key growth initiatives, including more R&D aimed at disruptive innovation, which refers to innovation which has the potential to create new markets and disrupt existing markets.”* Similarly stated in the previously three annual reports (2013; 2014; 2015). Broddner explains that this is mostly done through what 3M calls: “Big bets”, something he explains as an amassing in several key technical areas to connect personnel, research and cooperation. The essence of “Big bets” is that it is a centralized program that enables the ideation/creation of groundbreaking/breakthrough/disruptive innovations by searching the landscape for megatrends in 3M specified technical areas determined as the “Big bets”. According to Broddner, 3M focus mainly on discovering and creating disruptive innovations with 3M’s technology on mega trends. Mega trends try to reveal and identify things that might come in the future.

Moreover, regarding if 3M has a systematic way of finding products and services which might disrupt 3M, Broddner argues that due to 3M being a very diversified company with 24 different divisions and presence in over 70 different countries it is difficult for 3M to have a global/central competitive intelligence, therefore, it is up to the divisions to conduct and manage their own competitive intelligence. Nonetheless, 3M has a Corporate Enterprise Development program which *“look years out to see trends and opportunities that could help 3M leverage its technologies into “white spaces”—those untapped markets that the company had not yet entered.”* (3M, 2002: 171). 3M also use specific tools such as road-mapping to develop both sustainable and disruptive innovations (Broddner). These roadmaps are developed based on the global megatrends that are applied on different business areas. We look at what type of technologies we at 3M have and how it can fit in the future landscape, however, the technology mapping must be connected to the markets segments. An example of a successfully implemented technology roadmap could be the innovation on pressure ulcers (Broddner). In one of 3M’s Innovation stories (2012) they describe it as: *“In this case, a 3M product developer in Germany recalled reading that giraffes never suffer from venous ulcers. He wondered how that could be, given that the distance from their legs to their hearts is twice that of humans, requiring higher pressure to maintain circulation and putting more stress on veins. It occurred to him that the giraffe’s tough, non-elastic skin functions like a compression bandage, maximizing the effect of every muscle movement to optimize return of blood, preventing swelling and ulcers. With that realization, the 3M team began a quest for materials that would reproduce the properties of giraffe skin. While 3M curiosity stimulated the opportunity, collaboration propelled the momentum toward the solution.”*

In addition, technical audits have been a valuable form of feedback at 3M, working as a peer review process for R&D program strengths, weaknesses and probabilities of success, both technical and business. As Julianne Prager executive director, Corporate Technical Planning, explains it: *“The idea has been to provide internal appraisals of major R&D programs in the company’s many labs,”* (3M, 2002: 46).

After a sponsorship from Richard Carlton, 3M created its first Central Research Laboratory in 1937 with a twofold purpose: *“to supplement activities of 3M’s division labs that worked on product refinements and to explore independent, long-range scientific problems beyond the ken of any division.”* (3M, 2002: 17). Central Research has the mission to focus on long-range research and on new ideas with a time frame of 10 to 20 years. (3M, 2002: 228). In 2016, 3M also dedicated a research lab to Cartons memory – The 3M Carlton Science Center that: *“sets its sights on new ways to innovate and solve challenges around the world,”* (www.3m.com). Susan Kent, 3M Electronics Materials Solutions state: *“We are a new group, working on new products for new markets – like optical films that can go into augmented-reality wearable devices. It’s exciting that we are investing in higher-risk, higher-reward innovation.”* and Lee Stanek, 3M Aerospace and Commercial Transportation state: *“This space represents an opportunity to work differently. Sometimes that’s enough to cause you to think in a different way. Just like visiting customers, you see things in new ways. We don’t know yet what can happen.”* (ibid). Another similar lab was the Products Fabrication Laboratory, also known as the Pro-Fab Lab, and as Art Fry retired corporate scientist, Office Supplies Division explains it: *“Dick Drew took a bunch of misfits—people who wouldn’t fly in formation—and he put together a lab that created technologies that account for 20 percent of 3M’s sales in 2000.”* (3M, 2002: 26). Additionally, John Pearson retired vice president, Development, and Carlton Society member state: *“I could purchase stuff and build things, and the engineering department agreed to a hands-off policy. There was complete freedom to build and do.”* (ibid). During the Pro-Fab labs 20-year lifetime, it generated product breakthroughs that led to e.g. Scotchlite reflective sheeting, Micropore surgical tape, foam tape, decorative ribbon, face masks, respirators and started the experimentation with adhesives which decades later led to the development of post-it notes. Today, 3M has approximately 8500 scientists and researcher worldwide, laboratories in 36 countries and in 2015 they invested \$1.8 billion in R&D (www.3m.com).

6. Analysis and discussion

In this section, the empirics is analyzed and discussed.

6.1 The Internal Perspective

6.1.1 Human Resources

Due to the presence of a corporate team responsible for “possibility perspectives”, a centralized innovation platform searching for future trends and an increase in R&D spending specifically aimed for disruptive innovations, it can be indicated that 3M during later years have had an additional strategy for the management of disruptive innovations. Additionally, statements such as: *“We want to be the first to make our own best products obsolete; that way, it’s difficult for the competition to catch up.”* (3M, 2002: 120) stress that 3M indeed are aware of disruptive innovations and that they have been actively working with strategies on how to manage them. Yet, it seems that neither senior nor middle managers are specially educated in disruptive innovations or encouraged to specifically focus on such innovations, but they rather have an overall entrepreneurial spirit and are appointed based on their passion. This also indicates that senior managers are chosen for their ability to seize new opportunities instead of past experiences and accomplishments. Moreover, with regards to management’s short vs long-term incentives, it can be argued that both senior and middle managements’ incentives seem to be more of the shorter term as they are related to a quarterly business cycle. However, 3M as a company strongly enforces values of having patience to wait for profitability and have reward and acknowledgement programs for individuals and teams that have shown patience and stubbornness, two values that are important when it comes to managing disruptive innovations. Additionally, as Coyne’s statement: *“At 3M, we try to balance the pressure for near-term results against this understanding of the nature of innovation. We know that long-term sales growth and sustainable profits can only come from keeping one eye on the path directly ahead and one eye on the horizon.”* (2001: 1) and the employee bonuses for achieving the Thirty Percent goal might suggest that there are some long-term incentives for employees at 3M. Nonetheless, there does not seem to be any specific incentives for managers at 3M to put explicit effort into disruptive innovations, but rather more subtle incentives for everyone at 3M to contribute towards the long-run race.

Regarding the ownership dimension, it can be argued that 3M has been more influenced by professional managers than the actual founders. Consider for example the role of William McKnight. It seems that his philosophy of innovation, entrepreneurship, risk-taking and last but not least his initiatives such as the 15 percent culture and the Thirty percent rule have influenced how 3M has innovated and are still innovating. Indicating that it might also be favorable with a passionate professional manager facilitating innovation management.

Furthermore, when it comes to the employees at 3M, it could be indicated that they have little direct contact with markets and customers until later on in the new product process or through the stage-gate process where 3M standard procedures include market intelligence and voice of customer.

However, 3M employees seem not to have any regular market and customer contact. In addition, 3M is hesitant to involve outside expertise in the innovation phase as they have a strong belief in intellectual property rights, and are thus afraid that collaborating on innovation might make the process of owning the patent after the development of a new innovation difficult. At the same time, 3M strongly advocates for knowledge sharing throughout the company, indicating that using outside expertise in the sense of someone outside one's department, business unit or country is more common than outside of 3M. Also, with statements such as: *"Rather than protecting what they knew, 3M employees shared knowledge. I saw openness and a spirit of immense cooperation that helped people get things done. I soon learned that the most successful people at 3M were good at getting out of their offices, meeting people, interacting and knowing where to find the expertise they needed"* and *"The climate of sharing and openness is unusual here (...)"* (3M, 2002: 31-32) indicate that sharing inside expertise has been a common trait at 3M. And as technologies/innovations belong to 3M at large it might ease the barriers of collaborating on projects and providing input when necessary. Additionally, the existence of a favorable IT environment for in-house collaboration and knowledge sharing and the informal employee forums, indicate a presence of inside expertise collaboration which might help facilitate disruptive innovation management.

The entrepreneurial culture at 3M is suggested to depend a lot on the 15 percent culture which allows any employee at 3M to spend up to 15 percent of their working hours on projects and innovations that they feel passionate about, regardless if it has any direct usability for 3M. Because this 15 percent culture is strictly hands off for managers and come without specific requirements and welcome all ideas, it could be indicated that employees are indeed given freedom and flexibility to innovate as they see fit and they also have access to resources to do so in terms of lab space and working hours. However, to ensure that these projects indeed are free from managerial influence and can be implemented by any employee at 3M more rigorous research must be made; nevertheless, it could be indicated that 3M's 15 percent culture provides employees with opportunities to be entrepreneurial. Moreover, many successful innovations have come from the 15 percent culture e.g. the famous Post-it notes and Scotch tape suggesting that 3M's 15 percent culture works in practice.

Moreover, to secure the entrepreneurial culture, 3M constantly works with reviewing their intraprenurial culture, ensuring they hire people that have skills common for entrepreneurs and offer rewards and acknowledgement programs for those that have successfully innovated, stressing that there is an entrepreneurial culture within 3M. Additionally, 3M's culture seems to allow their employees to take certain risks, although 3M as corporation only takes calculated risks it appears to be more encouraged for employees to take risks as statements such as: *"At 3M there are no failures, just unexpected results"* (Broddner) and *"It's easier to ask forgiveness than permission"* (3M, 2002: 24) indicate. However, simply stating an open policy for risk-taking and failure is not the same as actually being open for it. Nevertheless, innovations that started off as grand failures e.g. Post-it notes could stay alive through e.g. employees' 15 percent time and through 3M's so

called ‘patient money’ which might indicate that the culture at 3M does encourage some risk-taking and personal initiative. Also, 3M’s recognition program for innovators that have stubbornly stood by and believed in their innovations until they have become successful further stress 3M’s encouragement towards risk-taking individuals.

6.1.2 Organizational Culture

Regarding the organizational culture at 3M, it is a very diversified company which has changed a lot during its existence, both regarding product lines, industries and organizational structure. The most recent change being the re-organization from 6 business groups to 5 and from 40 divisions to 24. Demonstrating that 3M, to some extent has the ability to change. Besides the presence of organizational changes in the past, 3M also actively works with change management as Broddner puts it: “... *because we constantly conduct so many changes.*”

With regards to flexibility in 3M’s organizational culture, it could be suggested that there is a strong organizational culture at 3M with a shared belief system around the company uniting all employees to ‘3Mers’. The culture can be seen as strong because employees continuously state the same values and as the values are reinforced through different reward and recognition programs. Yet, the company culture includes values of entrepreneurship, innovation, creativity, collaboration and openness, therefore, one might argue that the core values of 3M’s organizational culture is in itself allowing flexibility and adaptability. Moreover, as 3M has facilitated capabilities to learn and unlearn, it indicates that their organizational culture can change. In addition, the identity of being a ‘3Mer’ might also facilitate the preparation of change and unlearning as being attached to 3M rather than to a product, industry or business unit might prepare employees for future changes in 3M’s organizational structure or product lines. Likewise, 3M’s thirty percent rule i.e. that 30 percent of each division’s revenues must come from products introduced in the last four years is a strategic goal ensuring the capacity to stay flexible and adaptable.

6.1.3 Resource Allocation

Because 3M use the same stage-gate process and evaluation routine for all projects and innovations, it indicates that 3M have structured routines which they follow. On the same time, 3M’s open mentality towards all innovations: “*At 3M we’re a bunch of ideas. We never throw an idea away because you never know when someone else may need it*” (Art Fry cited in 3M, 2002: 38) suggests that there also are routines that allow for different ideas to stay alive at the company, indicating some degree of flexibility. Additionally, the 15 percent culture also suggests a flexibility in the routines to allocate resources as it allows every employee at 3M to use 15 percent of their time and effort in projects of their liking, no matter the idea or business case. Yet, due to the evaluation routines consisting of a non-flexible stage-gate process which includes certain financial measurements it seems more challenging for innovations of disruptive nature as they might not have the required profit margin or reach the market size requirement. Therefore, one could argue

that when it comes to commercializing new innovations there are structured routines that does not account for the different requirements and opportunities of sustaining and disruptive innovations, but regarding R&D and innovation at large at 3M one could say that there is an adaptability to the routines which enables both the exploration of disruptive innovations and sustaining innovations. Indicating that at 3M it is allowed to explore innovations that might be of disruptive nature and let them mature until a feasible or commercially viable business plan occurs.

In addition, 3M's 'patient money' indicates that resources are also allocated to ideas that might not have a sufficient business plan or even a clear usability for 3M i.e. an opportunity for disruptive innovations. 3M's three-tiered research structure, also ensures that resources are allocated between innovations tailored for specific markets with near-term perspective, new products with a 3-10 year perspective and on basic fundamental research with a long time horizon, further stressing that 3M allocate resources to both sustaining and disruptive innovations, understanding that disruptive innovations might require a longer time frame and might address long-range scientific problems beyond the ken of any existing division. Also, indicating that the allocation of new resources is not always dependent on 3M's existing portfolio and markets, but that they also invest in "*scientific solutions to life's challenges*".

Furthermore, 3M's special side program i3 where they invest in innovations based on suggestions from all business units on projects that could benefit from a fast track with the purpose of avoiding that these innovations get stuck in the system but rather evolve on the side of the regular 3M system. Indicating that there is a special investment possibility that might not require the standard stage-gate process. Likewise, programs such as the Genesis Program which funds projects that has not yet qualified for 3M budget support through the regular channels suggest some flexibility to investment decisions. Through 3M's history, Genesis grants have funded several successful innovations such as the Brightness enhancement film, something when it was first discovered had problems showing a clear business case for 3M, but today it is extensively used.

Additionally, to ensure they allocate resources not only depending on existing products and markets but also to new and emerging markets, 3M have had a Thirty percent rule, warranting that 30 % of all revenues must come from products that have been developed the last five years and 40 % of innovation development should consist of either a new product to an existing market, an existing product adapted to an emerging market or a completely new product for a new market. Indicating that 3M does focus on new and emerging markets and are not only depending on their existing products and markets. However, as the definition of a new product is ambiguous as it could also entail a new and improved version of a product i.e. sustaining innovations, thus, it does not guarantee that focus is put on disruptive innovations, but rather on innovation per se. Nonetheless, 3M's outspoken tradition of "*uninhibited research for uninhabited markets*" and "*following technology wherever it leads*" might further support that they indeed put effort into disruptive innovations. An example of how 3M have allowed the technology to lead the way is their

investment in fluorine chemistry. At the time when they did the initial investment they did not know how 3M would utilize it, instead they started experimenting without a specific product or customer in mind. Similarly, as the figure of nonwovens technology illustrate, (see Figure 3.) 3M has allowed technologies to evolve into products that was not originally thought of and they have let technologies be applied in different industries, even creating brand new industries. Another key enabler to follow technology wherever it leads at 3M might be that technologies are owned by the whole company not the different business units or divisions, which might benefit 3M not being too dependent on existing products and customers or staying stuck in the familiarity trap. It might also enable increased collaboration between departments and units to co-use and co-develop products and technologies. In addition, that technologies belong to everyone at 3M might also be one cause for the great diversity that 3M has managed to create over the years.

6.1.4 Organizational Structure

A key inhibitor for 3M with regards to disruptive innovations could be their large size (90,000 employees), however, to keep some flexibility 3M is structured into 5 large business groups and 24 sub-divisions. On the other hand, these business groups can still be considered large and inflexible rather than small and flexible, stressing that they might still act as an inhibitor for disruptive innovations; yet, because 3M has appointed many profit centers where division managers acts autonomously and is accountable for their own actions, it could be indicated that 3M's large size still allows for the smaller company feeling and flexibility to some extent. Nevertheless, more in-depth research would be needed to indicate whether the relationship between the size of the business groups and divisions has a correlation with 3M's ability to manage and create disruptive innovations. These suggestions merely stress that because 3M has structured the firm in smaller groups, divisions and projects with individual profit centers they might have enabled opportunities for disruptive innovations. Additionally, as 3M implement an organic organizational structure allowing for flexibility, decentralization of decision-making and low levels of formalization one could argue that the organizational structure allows for an entrepreneurial culture and innovative spirit.

Furthermore, 3M's "loose-tight" strategy might indicate that 3M to some degree are equipped with dual organizational structures to enable the management of both incremental and radical innovations or as O'Reilly and Tushman (2002) call it "ambidextrous" organizational abilities. However, as Yu and Hang (2010) conclude, possessing these ambidextrous abilities might not enable disruptive innovation as it is difficult for disruptive innovations to gain enough attention from senior managers and existing customers, thus, 3M's loose-tight strategy must be analyzed with caution. Nonetheless, it could be argued that the bare existence of a loose-tight strategy could indicate that 3M are aware of the different types of innovations and that they require different management, but for it to make a difference more research would be needed to show what the effects are of their loose-tight strategy.

3M's divide-and-grow philosophy i.e. spinning-off projects to divisions, and divisions to business units so that when the new business is separated, the established division need to find new products and markets to meet its growth objectives to compensate for the contributions from the business that became independent, indicates 3M's ability to change, ensure manageable size of units/divisions and that every project, division and business unit has the right management and autonomy for its purpose. Additionally, it suggests that there is a flexibility to the organizational structure at 3M to suit the needs of every project and innovation and might also induce existing business units not only focusing on existing product lines but to constantly seek new opportunities to come up with new innovations. Which might encourage managers to more evenly allocate their resources into both disruptive and sustaining new product development. That the divide-and-grow strategy really has been implemented at 3M could be argued as they have over the years become more diversified, dividing and growing innovations into new businesses. One example of such a divide-and-grow case is the re-organization of 3M's Reflective Products division into four separate divisions.

With regards to collaboration and open innovation at 3M it seems that 3M use a variety of the tools mentioned in Yu and Hang's (2010) article, e.g. acquisitions, strategic alliances, spin-offs and active participation in various forums. In times when 3M seeks to grow or enter a new business/industry they have acquired the necessary knowledge and competency to be able to succeed in the new market. Alternatively, 3M has acquired firms with the sole purpose of learning more about a specific technology. Indicating that when technology at 3M has led them into a new industry they complement the new business by acquiring outside expertise in the area which might enable disruptive innovations the opportunity to grow into real disruptions. Likewise, acquiring technologies for the purpose of learning and gaining knowledge could maybe enable the creation of new disruptive innovations. At the same time, as previously stated, it is difficult to discover potential disruptive innovations. Hence, this strategy might give ambiguous results, as it might generate disruptive innovations sometimes and more sustaining innovations other times or alternatively it might not generate any new innovations at all. Hence, 3M has divested and exited when acquisitions failed to generate synergies or new innovations according to plan. Moreover, as 3M has been criticized for the time they take to decide in matters of shedding businesses (3M, 2002: 201), it might be indicated that they indeed implement their "patient money", giving new technologies and innovation some time before deciding that they have failed, which could be enabling the management of disruptive innovation as these innovations usually take longer time before becoming profitable. Yet, one must regard these indications with caution and a more careful analysis should be conducted to seek out the intention behind the acquisitions and the actual results from the acquisitions to further discuss the relationship between 3M acquisitions and disruptive innovations. Additionally, as 3M also conduct acquisitions with the aim to strengthen their core business, it might be enabling both disruptive and sustaining innovations but favoring sustaining over disruptive innovations.

Furthermore, 3M's strategic alliance with Impel in 2015 was according to 3M entered with the objective to accelerate commercialization and cost effectiveness and to continue developing and commercialize the POD technology. Stressing that 3M entered the alliance based on an already likely commercially viable innovation. At the same time, 3M sees the POD technology as a solution to an unmet need in the drug delivery marketplace and the alliance as a way to support development of novel approaches to major problems confronting the pharmaceutical and biotechnology industries. Thus, it could indicate that the alliance aims to facilitate the development of an innovation that might have disruptive potential. Nevertheless, it is difficult drawing any conclusions from the alliance as it was entered recently and the results might not be evident yet. Although, it might still indicate that the intent of the alliance has been to further develop and commercialize this potentially disruptive technology.

Furthermore, 3M has shown their ability to grow with the support from alliances and outside collaborations which might have enabled opportunities for disruptive innovations. Trying to reach new customers and markets, 3M started to consider the automotive industry and after some initial customer and market research they could enter a very niche market of automotive parts. Additionally, acting as a little, entrepreneurial company with tremendous freedom and focusing on fast response time to customers. It indicates that in the initial phase when entering the new market, 3M were willing to enter with the probability of a small market share and niche customer base to instead later gather and gain the knowledge, experience and resources that was needed to gain a larger market share, which is important for enabling investments in disruptive innovation. Moreover, by building alliances outside the company 3M could continue to explore new possibilities and innovations that might lead to co-developed projects and maybe even disruptive innovations. Moreover, it can be argued that 3M saw the importance in collaborating with the "big players" when entering a new market, to gain knowledge and technological expertise, but they were also not afraid of entering alliances to see if they generated anything. On the other hand, 3M has also entered strategic alliance and joint ventures for other reasons, e.g. Dyneon L.L.C and Alventia L.L.C were both formed to gain competitive advantage in existing markets with existing products. Hence, it would be interesting to gain more insight into how 3M base their decisions for alliances and outside collaborations, how much focus they put on gaining fundamental knowledge and explorative innovation compared to competitive advantages and exploitive innovation during decision-taking.

Continuing to the dimension of spin-offs, one could argue that in the case of 3M, spinning off a business but keeping some ownership is not a common strategy. Nevertheless, one such example is when 3M spun-off their data-storage and imaging systems to create Imation (Glassbridge Enterprises). As a 3M "homegrown" business it had created pioneering technologies, created new global businesses and represented a significant share of 3M's total annual revenues, yet, they chose to spin it out as Charlton Dietz, retired senior vice president, 3M Legal Affairs stated: *"We had superior technology. We made magnetic media better than anyone else in the world, including the Japanese, but they were willing to accept a lesser profit. We thought we could be better*

technologically. Ultimately, we thought we could win. This drove the decision to spin off the business. We knew the new company (later called Imation) would have the best technology in the world." (3M, 2002: 209). Suggesting that when the technology is promising but not providing the necessary financial requirements of 3M, the option of spinning out exist but it might not have been spun out if it had the financials in order. Nevertheless, this strategy has not been very frequent during 3M's lifetime, hence, it should be considered more as a one-off strategy than a continuous one. Instead of completely spinning off businesses, 3M has encouraged spinning off projects within 3M corporation with their divide-and-grow strategy as discussed previously, suggesting that divisions and business units at 3M cannot rely solely on sustaining their existing products, but need to explore new innovations to meet growth and profit objectives. In addition, the divide-and-grow strategy also allow projects to have the size and autonomy they need, which could enable the management of disruptive innovations. According to Christensen and Raynor (2003) focus lies on processes and unique cost structures rather than geographic separation and ownership structure, therefore, 3M's internal spin-offs might be an example of the type of spin-offs that Christensen and Raynor argue as enablers for managing disruptive innovations.

With regards to forums, 3M have several internal global forums such as the Global Tech Forum and Marketing Forum, which facilitate a voluntary and informal knowledge sharing platform. *"The forum has not been bound by any set of rules but has been allowed to develop naturally."* (3M, 2002: 34), indicating that the forums are flexible and not steered by senior management. Additionally, the internal forums might be a way to discuss and explore new innovations within 3M, letting employees and experts from different areas of 3M meet to exchange ideas and experiences, which in turn could lead to disruptive innovations. More specifically focused on fundamental research and perhaps disruptive innovation might be 3M's internal forum The Carlton Society. As the Carlton Society provides opportunities to work across disciplines and collaborate others outside your area of expertise and encouraging mentorships it might be suggested that it might be supporting a culture of collaboration and entrepreneurship. 3M's many official pathways to support organizational communication and their robust culture of collaboration also stress their focus on collaboration and knowledge sharing throughout the company which might facilitate the diffusion of disruptive innovations.

In addition, 3M's participation in external forums such as The Innovation Roundtable, indicates that they actively engage in opportunities to discuss new innovations and technologies to gain knowledge and learn from other experts and companies around the world. External forums also facilitate connections between 3M experts and other external experts, however, if it leads to more collaboration and open innovation further research is needed to identify the effects of attending these external forums. Nevertheless, theory suggests that being close to the markets and scanning the landscape for new innovations and ideas increases the ability to manage disruptive innovations as it might prepare you for when disruptions might enter the market giving you the ability to act in an early stage. Additionally, 3M's web based forum, InnovationLive might facilitate a method for

internally scanning the landscape in search for future threats and opportunities that 3M's employees might anticipate.

Additionally, 3M call for collaboration with current and potential customers on their website e.g. *“The 3M team doesn't keep collaboration in-house. Let's talk about the design you want to achieve, or the issue you're trying to overcome, and together we're more likely to come up with a solution that works.”* Focus seems to lie on identifying problems and needs that 3M can solve, yet, this approach requires that customers actually know their future needs which might not always be the case. Additionally, as previous research suggests when it comes to creating disruptive innovations, the key lies in understanding customers' latent needs, which might be difficult if the customers themselves must come to 3M with their problems and potential needs. Therefore, this customer collaboration initiative might indicate good collaboration with current customers to further develop and sustain products based on 3M's existing product lines but seems more unprepared for innovations tailored for new markets, as these innovations seem to come more discontinuous and random based on latent rather than obvious need.

6.2 The Customer Perspective

6.2.1 Customer Orientation

3M's search for new and emerging markets partly consists of searching for “megatrends” from a centralized unit. Stressing that they not only focus on traditional market intelligence based on their existing customers, but that they also conduct research based on larger megatrends that might not be directly linked to any existing customers or markets. Nonetheless, it is up to the 24 divisions to decide which of these megatrends to research further and which customers to engage further with, therefore, simply having a unit for the research of megatrends might not be enough to actually create and manage disruptive innovations. However, it might shed light on how the landscape is changing and highlight when this might impact 3M. Nevertheless, it indicates that 3M is open to considering new customers and markets, which is important for the enablement of disruptive innovations. Additionally, as 3M today is a diverse company which addresses various customers and markets, one might also assume that they indeed are open for new customers and emerging markets. 3M's customers' base has also changed over the years as they have entered new markets and divested others, indicating that they possess the ability to add new customers and address new markets which according to theory might be vital for the enablement of disruptive innovations.

Furthermore, 3M Ventures indicate that 3M indeed focus on new and emerging customers and markets and that they are willing to invest if opportunity arise, either with equity or through alliances. Because: *“3M New Ventures was created to strengthen 3M's position at the leading edge of global innovation by complementing 3M's holistic innovation strategy with a focus on disruptive, early stage innovations outside of the company's existing portfolio”*, it might indicate that the 3M Ventures business is a means for 3M to ensure that they keep a broader customer orientation. As it

is easier for those at 3M Ventures to think outside the 3M box and they can be more objective to opportunities and new ideas as they appear not being bound by existing industries or customers.

Additionally, 3M's goal of investing 40% of all investments into innovations that regards a new product to an existing market, an existing product to a new market or a new product to a new market, indicates that they actively try to find new customer and market segments to enter. Even though 60 % of their investments are focused on existing business, their outspoken intention to invest 40 % into these class 4 and 5 innovations might suggest that they to some degree treat disruptive and sustaining innovations differently. Note, that 3M might not be using the distinction of disruptive and sustaining innovations, but, their actions suggest that they are making a distinction between the two even though they call them by different names. Nevertheless, it is not as easy as saying that 3M focuses 40 % on solely disruptive innovations, this can also include innovations that are more of the radical sense than disruptive. However, as Govindarajan and Kopalle (2006) argue, some disruptive innovations can also be radical. Additionally, some of 3M's innovations can also, in fact, be of the sustaining trajectory. Yet, the existence of an outspoken policy that distinguishes between existing and "new business" might stress that 3M are aware of the different types of innovations and that they require different management.

6.2.1 Customer Needs

3M repeatedly state: "*know your market well enough to anticipate your customers' wants and needs even before they do*", indicating that they are interested in understanding customers' latent needs. Moreover, using tools such as field observation, focus groups, lead user process and Innovation Centers advocate that they actively implement methods to gain knowledge and understanding of customers' unconscious needs. However, many of these tools have been implemented on their existing customers or within their target market which might suggest that even though they address customers' latent needs they are not focusing on non-consumer segments. For example, their Partnership in Patient Care is specifically formed to better understand their current customers' environment and their "customer intimate" strategy also seems to focus on maintaining a relationship with existing customers, to help improve/ sustain products or to create new products. Nevertheless, when entering the ergonomics market, 3M conducted field observations to understand problems that others were experiencing and then solved the problem by applying an already existing 3M technology on the issue, indicating that these processes also can led to new customers. Additionally, 3M's use of the lead user process as a way to integrate with experts and leading-edge customers to collaborate on the breakthrough innovation frontier indicate an effort to gaining insight into what other experts and scientists are working on and the needs that lead-user customers are experiencing. As the lead user process is flexible in the sense that you follow where the findings lead you, it provides a method that might lead to disruptive innovations for new and emerging markets and customers. For 3M, it led them into the emerging market of medical supply for developing countries. The process led 3M into a new market addressing new customers which also required the division to change to accommodate these new segments, stressing that 3M has

the ability to seize the chance to enter a new market or address new consumer segments and that they have flexibility in their organization that new markets and customers might require.

6.3 The Technological Perspective

6.3.1 Systematic approach

As 3M has increased the amount invested in R&D and directing the increased amount towards disruptive innovations, one could argue that 3M during the latest years have actively focused on disruptive innovations which they define as “*innovation which has the potential to create new markets and disrupt existing markets*”. Their Thirty percent rule and the 40 percent initiative towards class four and five innovations also suggest that they have been intentionally striving to come up with new products to potentially disrupt existing markets, enter new markets or create new markets. Additionally, their tradition of consistently investing in R&D, during good and bad years also stresses their commitment to research and innovation. Nonetheless, simply investing money towards the development of disruptive innovations might not generate any innovations, thus, it is more interesting to see what tools that 3M has used to systematically search for disruptive innovations or for creating their own disruptive innovations. One such tool might be the lead user process discussed earlier, as the process aims to systematically find people and organizations on the cutting edge to create breakthrough innovations and identify new emerging markets it might be suggested as a tool for scanning the landscape for potential disruptions as well as a means to generate new disruptive innovations. Yet, the process is not solely focused on disruptive innovations, but could also generate more sustaining innovations, hence, it would require more research to underline if this process is an enabler for disruptive innovations or not.

Another tool might be 3M’s “Big bets” and their search for megatrends attempting to reveal and identify things that might come in the future. Yet, it is up to the divisions to actually invent something base on these megatrends and to conduct relevant competitive intelligence. On the other hand, because the divisions conduct their own competitive intelligence it might indicate that they work more closely with the markets and thus can gain better customer foresight. Nevertheless, it is a conscious and continuous strategy for identifying future trends which might increase the likelihood of discovering a disruption in time to react and 3M’s Central Enterprise Development program is also a tool seeking trends and opportunities that could help 3M leverage its technologies into “white spaces” i.e. untapped markets which might enable the discovery of disruptive innovations. In combination, 3M’s road-mapping process based on the global megatrends, suggest that 3M has a strategy for how to generate innovations, some of which might be of disruptive nature. However, as the technology mapping must be connected to 3M’s markets segments it might indicate that it enables the discovery of sustaining innovations to a greater extent than disruptive, as disruptive tend to be difficult to connect with an existing market segment before it is discovered. Future research can continue to investigate the usefulness of roadmaps and how they should be formed to enable the best success; however, firms tend to be reluctant to give away too much

specific information regarding their recipes for developing new innovations making it difficult to access information.

Moreover, 3M’s technical audits can be seen as a systematic way to evaluate and bring new ideas to R&D projects at 3M and ensure that projects around their different labs are collaborating when necessary. Laboratories such as Central Research, 3M Carlton Science Center, Pro-Fab Lab suggests that 3M provides the opportunity to conduct research that is fundamental, long-term and independent from existing customers and markets which might indicate that they are more open-minded and therefore also more able to create disruptive innovations instead of only sustaining. The focus does not have to be on developing new products but to explore new technologies that in the future may or may not generate new products. Additionally, 3M’s strong focus in IPR and patents, might enable their focus on fundamental research as these innovations still can generate revenue because even if 3M might not end up using the technology other firms might which will generate revenue through the patent protection.

6.4 Discussion

Table 2. Summary of main findings

Concept:	Main findings:
Human resources	<ul style="list-style-type: none"> • Team responsible for possibility perspectives and future trends • Active strategy towards disruption, understand the force of making own products obsolete • Strategy of 30 % of revenue should come from products introduced in the last four years and 40 % of development should be in class four and five innovations • Subtle incentives such as reward and recognition programs • Influence by professional managers rather than founders e.g. the role of William McKnight • Entrepreneurial traits common both for employees and for managers. • Allowing and encouraging risk-taking behavior on individual level • 15 % culture to foster an entrepreneurial and innovative climate • Intraprenurial guidelines and assessments to ensure the entrepreneurial culture • Little involvement of outside expertise, but high inclusion of internal knowledge sharing and collaboration within 3M • Facilitating knowledge sharing and collaboration within 3M by owning all technologies together as a company instead of per business unit, having favorable IT-environment and providing internal forums for collaboration • Direct contact with customers and markets come in later stages of the development process with market intelligence and voice-of-customer.
Org culture	<ul style="list-style-type: none"> • Experience of change by changing industry, conducting re-organizations and allowing technology to lead the way • Ability to change and unlearn with active change management, norms of being a 3Mer instead of being too attached to a specific division or product and core values such as entrepreneurship, innovation, creativity and risk-taking • Flexibility and diversity is created with strategies such as the Thirty percent rule that each division’s revenues must come from products introduced in the last four years, and 40% goal of developing new products to an existing market, modifying an existing product to a new emerging market or developing a completely new product addressing a new market

Resource allocation	<ul style="list-style-type: none"> • Follows structured routines by using a strict stage-gate process for all new product commercialization's, but keeps some flexibility by allowing research to continue even if innovations do not fit in the traditional stage-gate process • Scholarships for innovations created on the 15 % time and for innovations that do not meet the business requirements • Patient money allowing for innovations to take time and business sense to appear • Ensure even allocation of resources through their three-tiered research structure, divide-and-grow strategy and their goal of having 30- 40% of the portfolio/development consisting of new products or addressing new markets • Technologies belonging to the whole company instead of business units might incentivize the search for innovation or exploring new ways to apply existing technologies
Org structure	<ul style="list-style-type: none"> • Despite 3M's large size, they have a small company atmosphere with 5 business groups, 24 sub divisions and many profit centers • Organic and decentralized organizational structure • Loose-tight strategy which might be facilitating dynamic capabilities • Divide-and-grow strategy spinning off projects to divisions, and divisions to business units allowing flexibility to the organizational structure so that all projects have appropriate size, management and autonomy also as a strategy to create internal spin-offs within business units. • Acquisitions to acquire necessary knowledge and competency when entering new markets or to learn more about a specific technology • Enter strategic alliances to facilitate development of novel innovations but for commercially viable products • When entering new emerging markets 3M encourages various alliances and collaborations to explore new innovations and co-development projects, especially with the "big players" in the field • Facilitate knowledge sharing and learning in various external and internal forums such as Global Tech Forum, Marketing Forum, Innovation Live, The Carton Society and The Innovation Roundtable,
Customer orientation	<ul style="list-style-type: none"> • Megatrend spotting from a centralized unit complementing traditional market intelligence • Diverse company with a diverse customer base that has changed over the years indicating an openness towards embracing new customers and markets, not rigidly focus on current traditional customers • 3M Ventures focus on emerging markets and disruptive innovations ensuring a broader customer orientation • The 30 – 40% goal of developing new products or addressing new emerging markets enables a focus on searching for potential new customers and stress that a distinction is made between sustaining and disruptive innovations
Customer needs	<ul style="list-style-type: none"> • Field observations, focus groups, lead user process and Innovation centers to gain knowledge and understanding of customers' latent needs
Systematic approach for identifying disruptions	<ul style="list-style-type: none"> • Increased amount in R&D towards disruptive innovations • 30 – 40% initiatives stress active strategies towards the creation of disruptions • Tools for finding and developing disruptive innovations e.g. the lead user process and technical roadmaps • Big bets and megatrends are ways to systematically search the landscape for future disruptions • The Central Enterprise Development Program also tries to identify ways to leverage 3M technologies into white spaces (untapped markets) • Technical audits • The Central Research, 3M Carton Science Center, Pro-fab Lab are all examples of laboratories that are aim to conduct research that is fundamental, long-term and independent from existing customers and markets i.e. opportunities to discover disruptive innovations • Strong sense of IPR might enable fundamental research in areas outside 3M's usability

The findings suggest that 3M's innovation management over the years is a complex matter and that the different perspectives mentioned in Yu and Hang's (2010) article might be important to consider. Additionally, it seems that the various innovation enablers for disruptive innovation are closely linked together and are thus difficult to isolate and analyze individually, further stressing the need of a holistic theory including the various perspectives and dimensions. Henceforth, it seems that Yu and Hang's (2010) framework is valid and an important contribution to consider in innovation management contexts. In 3M's case, for example, their 15 % culture might not have worked very well if they did not simultaneously insure access to resources through e.g. scholarships and Genesis Grants, or by recognizing and rewarding employees that come up with innovations during their 15 % time. The entrepreneurial environment at 3M e.g. internal forums, sharing technologies, allowing risk-taking and hiring innovative and creative employees might be factors facilitating the 15 % culture as well. Along with being a company that has changed direction and industry before where people see themselves as 3Mers instead of being attached to a single product or industry might also have enabled successful innovation management at 3M. In combination with 3M's divide-and-grow strategy allowing manageable organizational sizes, autonomy and flexibility for projects and innovations to foster. Therefore, agreeing with Sandström et al. (2009) that firm specific characteristics are important to consider when researching innovation management and disruptive innovations. For example, in 3M's case, their characteristic of being very diversified into many industries could be a factor contributing towards their successful innovation management as it might allow for more flexibility than a company that only acts in one industry. Nevertheless, more rigorous research is needed before any conclusion can be suggested.

Furthermore, it seems that in the case of 3M, some of the enablers appear to be less important. For example, having specific long-term, subjective incentives for senior and middle managers to actively consider disruptive innovations does not seem to have been very important, as 3M instead has focused on more subtle incentives with the 30 and 40 percent rules and internal reward and acknowledgement systems etc. With regards to the ownership dimension, it seems not to be the founders but the professional managers that have influenced 3M's innovations management the most. Therefore, agreeing with previous research that senior management is important to consider (O'Reilly & Tushman, 2008; Sandström et al., 2009; Christensen & Raynor, 2003), however, contrary with research that suggest that founders compared to professional managers might have a better ability to tackle disruptions (Yu & Hang, 2010).

Additionally, instead of involving outside expertise to a large extent, 3M has focused on utilizing their own expertise and ensure a healthy environment for internal collaboration and knowledge sharing. However, it should be noted that exploiting internal expertise instead of external might only be useful for large global firms as they have access to a broader knowledge base. With regards to employees having regular direct contact with customers and markets, it does not either seem to have been instrumental in 3M's innovation management, as they normally do not have regular contact but rather involve customer and market contact later in the development process, suggesting that this enabler has not been too important. Additionally, the actual size of business units does not appear to affect a lot either, what seems to be important is the ability to change size and autonomy

as projects and innovations are developed and grow. Which goes hand in hand with previous research that there is a balance between needing big units to e.g. sustain scale/scope effects and architectural interdependence and needing small, flexible units able to adapt to suit a new innovation or technology, thus, one might suggest that the flexibility dimension is more important than the actual size or autonomy of business units. In addition, when regarding the systematic approach for identifying and creating disruptive innovations, it seems that having clear cut roadmaps are more useful for sustaining innovation management than disruptive as usability for 3M and connection to their market segments must already be in place. Yet, the systematic approach of searching for megatrends and big bets might be enabling 3M's innovation management as it provides analytics on how the future might change which increases the likelihood of discovering potential disruptive threats and opportunities before it is too late.

7. Conclusion and suggestions for future research

This concluding section summarizes the main findings of the paper and presents suggestions for future research.

7.1 Conclusion

This paper sought to gain a deeper understanding of incumbents' process of managing innovation. With the three different perspectives presented in Yu and Hang's (2010) article as analytical guidance, it was possible to explore how large global incumbents manage innovation over time and overcome the innovator's dilemma with empirics from the 3M Corporation. Both primary and secondary data from an interview with Pontus Broddner, 3M's 'A century of innovation: The 3M story' (2002), 3M annual reports (2012, 2013; 2014; 2015), 3M website, press releases and previous research was used to gain a longitudinal perspective of 3M's innovation management.

Based on the findings, it seems that to enable disruptive innovation management and overcome the innovators dilemma, it is indeed important to have supportive human resources such as senior and middle managers that understand the importance of innovation and encourage risk-taking and collaboration whether it is external or internal or why not both. Additionally, having employees that possess entrepreneurial traits, are creative and risk-taking also seems important to facilitate an innovative atmosphere. However, without supporting resource allocation that is focused towards both sustaining and disruptive innovation or short-term and long-term innovation the entrepreneurial culture might not enable disruptive innovations. Hence, it is vital to consider various perspectives and dimensions when analyzing innovation management. Moreover, the organizational culture, also plays an important role, yet, maybe a more important aspect, at least in the case of 3M, might be that the organizational culture is flexible and that there is an ability to unlearn. Also, enforcing values of a strong identity towards being a 3Mer instead of feeling attachment to a division or product, along with core values of entrepreneurship, innovation and cooperation might facilitate 3M's innovation management. Additionally, 3M's organizational structure of structuring into smaller business units and divisions, having many profits centers and having an organic and decentralized organization seems to facilitate their innovation management. Along with strategies such as divide-and-grow and loose-tight 3M have enabled the suitable size, autonomy, capabilities and flexibilities necessary for different projects. With strategic acquisitions and alliances, they have, to some degree, managed to gain knowledge, learn about new technologies or co-develop innovations and projects. Additionally, external and internal forums might have enabled innovation and disruptive innovation through knowledge sharing, collaboration and scanning the landscape for future threats and opportunities. 3M's customer orientation being open-minded for new customers and actively searching for new customers and markets instead of solely focusing on traditional market intelligence and existing customers seems also to have supported their disruptive innovation management with specific tools such as 3M Ventures, 40 % initiative and megatrend spotting. To gain insight on customers' latent needs 3M's has e.g. used field

observations, focus groups, lead user processes and Innovation centers which might have enabled their innovation management towards disruptive innovations. Approaches such as road-mapping and active R&D spending towards disruptive innovations along with specific laboratories and programs aimed towards long-term innovation, fundamental research and ways to tap into white spaces might also have helped to facilitate 3M innovation management and overcome the innovators dilemma.

Overall, the findings advocate that holistic innovation theories might be suggestable when discussing innovation management both with regards to theory generation and management practice, due to innovations complex nature and the interactions between the various innovation enablers. In addition, suggesting that Yu and Hang's (2010) framework possess some explanatory power for how incumbents manage innovation over time, stressing that it could be imperative to include various perspectives when explaining and theorizing around innovation management and the innovators dilemma. Increasing the understanding of various firm specific characteristics also seems imperative when discussing holistic innovation theories.

7.2 Future research

As previously mentioned, the findings concluded in this paper regard 3M, and therefore cannot be generalized to be valid for all large global firms, but can rather be seen as indications of how large global firms might enable innovation and manage the innovators dilemma. In addition, it is difficult to isolate the findings of 3M's innovation management, making it difficult to prove they are definitely caused by 3M, hence, lowering the internal validity of the study. Therefore, it could be motivated for future research to test if the enablers presented seem to be vital for similar cases. Future research could also explore how the various perspectives interact to suggest a more holistic theory of how to manage innovation and disruptions. Additionally, it might be interesting to further investigate the possible tradeoff or relationship between IPR and open innovation/ external collaboration. Also, more research on the technological perspective might be called for to gain better understanding on the different tools and systematic approached for disruptive innovations.

To conclude, this paper has explored the phenomenon of 3M's innovation management and their approach towards the innovators dilemma, suggesting that some of the enablers identified by Yu and Hang (2010) seem more vital than others. Indicating a more concise and holistic theory of how to manage innovation at a large global firm and overcome the innovators dilemma. Additionally, proposing that the three perspectives (internal, customer and technological) possess some relative explanatory power of the enablers that facilitate innovation management and disruptive innovations, stressing the usefulness of holistic innovation theories.

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9. Appendix

Table 1. Operationalization¹

Concept:	Dimensions:	Indicators:	Measurement instrument:
1. The internal Perspective			
Human Resources	Senior Management	Additional team at the corporate level responsible for disruptive innovations	In the annual report, it is stated that 3M is investing a lot in disruptive innovations; can you elaborate a bit on this? Also, does this imply that there is a separate team on corporate level that is responsible for disruptive innovations?
		Understand the promise of disruptive innovations, focus on new opportunities instead of current experiences	How can senior managers seek and seize new opportunities? How are senior managers selected? Future ability vs past experience? Have senior managers, middle managers and employees been educated/ made aware of what disruptive innovation is and how they can manage it?
		Long-term and subjective based incentives	What type of incentives does senior management have? Long-term vs short-term? Give examples.
	Middle Management	Long-term and subjective based incentives	What type of incentives do middle managers have? Long-term vs short-term? Give examples.
		Focus on sustaining or disruptive innovations	How is middle management encouraged to focus on disruptive innovations? Provide examples.
	Ownership	Founders vs professional managers	
	Employees	Risk-takers, entrepreneurial	Can you describe a typical employee? Can anyone at 3M come up with an innovation? Do you have an example of when a regular employee has initiated a new innovation?
		Outside expertise	When it comes to coming up with new innovations, would you say that 3M is open or hesitant to involve or hire outside expertise? If open, do you have an example of when 3M has involved outside expertise? Have you recruited or worked with any outside expertise?
		Degree of direct contact with markets and technologies	Do regular employees (i.e. not managers) interact with or have any direct contact with the markets and technologies that they work in? Elaborate, give examples.
	Organizational culture	Org. change	Number of organizational changes
Prepare for and institute org change, along with unlearning processes			I understand that 3M actively works with Change Management, can you describe in what ways you work with change management? E.g. how do you prepare for future org. changes?
Flexibility		Values and degree of re-enforcement	What core values do you at 3M work by? How well are they re-enforced? Are the controlled?

¹ This table is based on Yu and Hang's (2010) article and it is created exclusively for this thesis

	Entrepreneurial culture	Entrepreneurship, risk-taking, creativity	Can you describe the culture at 3M? You are famous for your entrepreneurial and risk-taking culture (<i>"It's better to seek forgiveness than to ask for permission."</i>), can you describe how you allow/ encourage entrepreneurial and risk-taking behavior? This must mean that there have been failures, can you give an example of a failure that has come from this risk-taking behavior? In what way does 3M as an organization encourage creativity?
Resource Allocation		Evaluation routines e.g. different criteria for disruptive ideas than existing business	Do you have different evaluation routines depending on the type of innovation/project? Do you have different evaluation routines for sustaining and disruptive innovations?
	Structured routines	Degree of flexibility of routines e.g. always use traditional marketing reports or same evaluation of financial returns	When you evaluate both potential and existing investments/projects do you always use the same evaluation matrix/ criteria? Is there any specific type of market reports that you always need before making investment decisions? Do you have strict routines for how you should evaluate financial returns? Can these routines change?
	Resources dependence	Investment based on the profile of existing vs non-existing resources	Do you normally invest more in businesses where you already are familiar and have resources or do you tend to accumulate new resources where you currently don't have any resources? Do you have an example of that?
		Focusing on new emerging markets and customers	When you take investment decisions do you normally consider your traditional markets and customers (i.e. core, mainstream) or do you consider new and emerging markets and customers?
Organizational structure	Business Units	Number of units	Since 2012, 3M has realigned from six business groups to five and from 40 businesses to 26. Is it common that you change the structure or number of units that you have?
		Size of units	How large alt. small are 3M's business groups and businesses? Do you have different sizes? If so, how come? Can you give an example of one of the smaller units?
		Degree of autonomy	What degree of autonomy/freedom do you give business units? Do some have more or less autonomy? If so, why? Does 3M have any business units that are almost completely autonomous?
	Collaboration and open innovation	Acquisitions	In 2015 3M invested nearly \$4 billion in acquisitions. What was the main underlying reason for the acquisitions? Were any of these acquisitions aimed at getting access to/ creating potential disruptive innovations?
		Alliance	What is usually the underlying reason when 3M enters a strategic alliance? Have 3M entered an alliance due to the detection of a potential disruptive innovation or with the aim to create a potentially disruptive innovation?
		Spin-offs	Have 3M created any spin-offs i.e. completely isolated autonomous organizations? If so, can you give an example? (e.g. <i>3M's spin-off of Data-storage and imaging systems created a new company called Imitation in 1995</i>)
		Forums	Does 3M participate in any forums? Which? Internal/external? Are there any specific criteria or routines for which forums employees can attend?

2. The Customer/Marketing perspective

Customer orientation	Customer and market focus	Ability to add new customers to address new markets	How would you define 3M's main customers? Even though xx is your main customers do you still consider other segments as well? If so which segments and why? Has your customer orientation changed over time? Give an example
		Emerging vs established markets	How much focus does 3M put on emerging alt. established markets? (research, resources, investment etc.)
Customer needs	Understanding customers' latent/unconscious needs		Finding and understanding new and emerging customers and markets is easier said than done, what is 3M's strategy? Which tools and methods do you work with to understand customers' latent needs? Could you give an example of a situation where 3M has commercialized a product or service for a customer segment that previously did not exist?

3. The Technology perspective, technological strategies for disruptive innovation

Systematic approach to identify or create disruptive innovations	Technology road-mapping that purposely create candidates for disruptive innovations	Active R&D Strategies for creation of disruptive innovations	In the last three annual reports it is stated that you invest a lot of your R&D investments into disruptive innovations, can you describe shortly how you actively work with disruptive innovations? Are you seeking to create/come up with new disruptive innovations?
		Clear cut road-map	Do you work with tools such as a road-mapping to help coming up with specifically disruptive innovations? If yes, do you have an example of where road-mapping has helped to create a new product or service?
	Scanning the landscape for new disruptive innovations	Analytics/analysis	Does 3M actively search for potential disruptive innovations that other researchers, firms or start-ups might be working on? If so, do you have a systematic way of scanning/analyzing the landscape for disruptive innovations?