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1.0 Management of Technology and innovation: overview

1.1 Introduction

How do firms manage technology and innovation to realize commercial benefits? This paper focuses on answering this crucial question as part of the entrepreneurial process and innovation in a business enterprise. The paper lays out a foundation for understanding technology and innovation as part of entrepreneurship. It does so by establishing some of the basic definitions and looks at factors that shape technology management, the tools of technology and innovation management in a commercial enterprise.

2.0 The aim of the paper

The aim of the paper was to critically review the management of technology and innovation management, importance of innovation and technology management, explain the significance of technology, innovation and their management in an enterprise and then describe the process of managing innovation and technology for profit

3.0 Concept of technology and innovation management

White, M et.al (2011), argue that technology has been in a variety of ways. It is important to recognize the various approaches to the definition before we build on to focus on the aim of this paper. This range of definitions demonstrates that a variety of different perspectives on technology exists. A few of the major definitions of technology include the following:

- The processes used to change inputs into outputs
- The application of knowledge to perform work
- Theoretical and practical knowledge, skills, and artefacts that can be used to develop products as well as their production and delivery system
- The technical means people use to improve their surroundings
- Free application of science, especially to industrial or commercial objectives, the entire body of methods and materials used to achieve such objectives

(White et al.2011)

Although there is a wide variety in the prior definition of technology, there are also some common elements in each of the definitions. Each definition implies that there is a process involved in technology, that change is an outcome of technology and that technology involves a systematic approach to delivering the desired outcomes (Improvements, objectives, productivity, efficient delivery system and outputs). For the purpose of this paper, we integrate these various definitions to define technology as the practical implementation of learning and knowledge by individuals and organizations to aid human endeavor. Technology is the

knowledge, products, processes, tools, and systems used in the creation of goods or provision of services to customers.

This definition has a strong systems view, as illustrated in figure 1.2. A systems view presents the firm as an association of interrelated and interdependent parts. The systems approach to implementing technology involves a framework of inputs, transformations, outputs, and feedback along the entire process. It also involves individuals, groups, and departments that form the organization and the external environment that impacts the firm

3.1 Definition of management of technology

The definition of technology also implies a process that involves the elements of strategic management. Therefore, the definition of management of technology should also reflect this systematic, strategic approach. Such an approach requires an integration of different disciplines to the management of technology (White et al. 2006). The various disciplines that can influence the management of technology and innovation ought to be critically reviewed in this paper.

White A. M & Bruton. G. Y (2011) argue that the definition of technology also implies a process that involves the elements of strategic management in order to respond to the external factor. Therefore, the definition of the management of technology should also reflect this systematic, strategic approach. Such an approach requires an integration of different disciplines to the management of technology. Figure 1.3 illustrates the various disciplines that can influence the management of technology and innovation. One of the most commonly cited definitions of the management of technology is consistent with this integration view.

Management of technology is defined as linking “engineering, science, and management disciplines to plan, develop, and implement technological capabilities to shape and accomplish the strategic and operational objectives of an organization.”

Figure 1.1 definition of technology and innovation

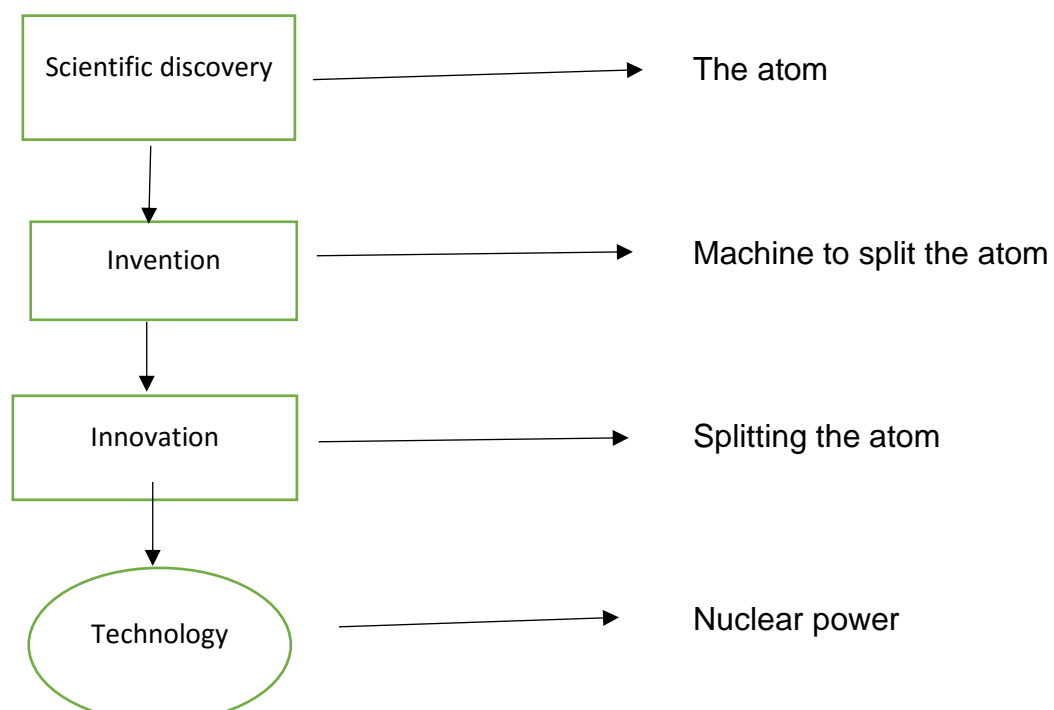
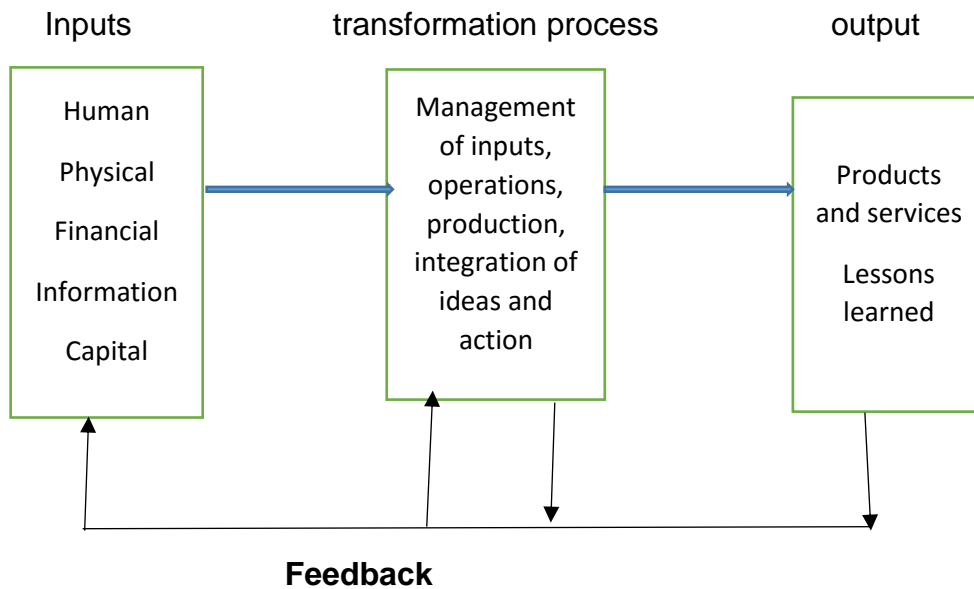
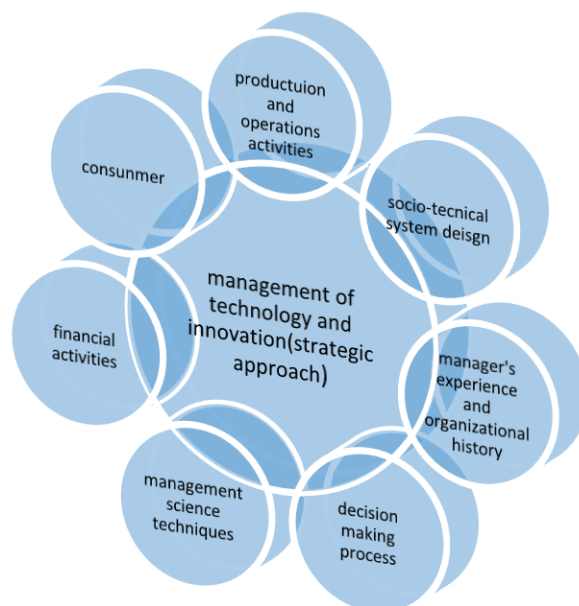


Figure 1.2 systematic view of an organization in the definition of technology



Source: Management of technology and innovation by White A. M

Figure 1.3 Areas influencing the management of technology



Source: Elliot Mumba, 2017

3.2 The significance of technology, innovation, and their management

3.1 A brief overview of technology management by GE

The successful management of technology and innovation has become one of the most critical aspects of business today. To recognize the importance of the management of technology and innovation (MTI) one can simply look at the impact of those skills on many of the leading firms around the world. Here is a brief overview of one of the world's leading technology firms, General Electric (GE). This overview illustrates many of the topics included in this part of the paper by the Author, the significance of technology management to the commercial enterprise.

3.2.2 GE: The Firm's History –case study

Today, GE is one of the world's leading firms. Their products range from the light bulb, invented by GE's founder, Thomas Edison, to the handheld ultrasound machines that are revolutionizing the practice of medicine around the world. GE is the only firm that was included in the original 1896 Dow Jones Industrial Average that still operates as an independent firm. This highly diversified firm has over 300,000 employees worldwide and in 2016 had revenues over \$400 billion, with net income exceeding \$60 billion. GE is composed of a number of business units—some of which would be in the Fortune 500 if they were independent firms.

How GE grew from Thomas Edison's small research facility in Menlo Park to today's multiproduct, global giant is through a process and pattern of strategic decisions that include acquisitions, divestitures, innovations, and reorganizations. GE was founded in 1890 when Thomas Edison brought his business interests together and formed Edison General Electric. Edison GE then merged with Thomson-Houston Company in 1892. This set the pattern of innovation and acquisition that is part of GE today. Throughout its history, GE has been a leader in patent applications and has acquired and divested a number of businesses in its drive to remain a leading innovator with a competitive advantage. GE throughout its history has caught each new wave of innovation as it has emerged. GE caught the initial wave of innovation that occurred around electricity. The firm then was able to catch the next wave of innovations that included trains and radios. GE began manufacturing diesel locomotives and founded Radio Corporation of America in 1919. This pattern of innovation continued in World War I as GE used its engineering knowledge to move into the aircraft engine business.

3.2.3 GE pioneered and laying the Foundation for superchargers for airplane engines.

This innovation made it possible for aircraft to go higher and faster. Throughout the decades between WWI (World War 1) and WWII (World War II), GE continued to develop turbo superchargers. When WWII started, GE was in the unique position of being the leader in the development and manufacturing of exhaust-driven supercharging engines. Superchargers later became a key element in jet engines. As a result, as airplanes changed from propeller powered to jet powered. GE became a dominant player in the industry. The result is that today GE is one of the leading manufacturers of jet engines in the world. In recent years technology has opened up new entertainment domains. Seeing this trend, GE today is the

third largest media conglomerate in the world. Technology has allowed many firms to enter financial business domains. Again, GE responded and now GE Financial is one of the world's largest financial firms in both the consumer and commercial markets. GE is also extensively involved in the green energy sector as a major manufacturer of wind turbines for electricity generation. And, of course, GE still makes light bulbs. This brief history demonstrates how GE was able to take advantage of and advance with major technological changes in the general business environment. If the firm had remained focused solely on light bulbs, it is doubtful the company would still exist. Instead, the company has taken advantage of environmental changes through strategic management and implementation of new technologies.

3.2.4 How GE Changes

In reviewing GE, it is critical to realize that the firm did not simply state, "We want to take advantage of changes in technology." Instead, the firm made numerous changes in its organization, including structure, personnel policies, and leadership, to make taking advantage of changes in technology possible.

To illustrate this aspect, in 2002 GE introduced its compact ultrasound machine. This machine sold for \$30,000 and combined a laptop computer with sophisticated diagnostic software. GE followed this innovation five years later with a model that was half the price. While this machine does not have the clarity of GE's large ultrasound machines, which cost seven to eight times more, the portable ultrasound is usable in areas of the world where it operates in hospitals.

3.2.5 Laying the Foundation

The portable ultrasound machine is a growth product in China, India, and other countries where medical facilities are scarce. But developing this product required that GE also makes changes in its processes and structure. The norm in product lines is to have a single integrated business unit for the global market. However, GE recognized that even though the large conventional ultrasound and the portable machine were related, the placement and functionality were very different. Therefore, GE created a facility for portable ultrasounds in Wuxi, China. Thus, the firm created a new organizational unit to handle this product. Not only is the unit separate but the organizational processes and policies were implemented to meet this unique market. This involved an innovative way of building structures known as local growth teams (LGT) and processes that followed five critical principles:

- Shift power to where the growth is
- Build new offerings from the ground up
- Build local growth teams like new companies
- Customize objectives, targets, and metrics to fit the business you want to grow
- Have the local growth team report to someone high in the organization so that appropriate resources are available.

From the beginning with portable ultrasound machines, GE now has expanded its local growth process to include more than a dozen LGTs in China and India. This has powered much of GE's recent growth.

1. To further push innovation GE introduced (2005) Ecomagination. GE CEO, Jeff Immelt, announced at the time

“GE will help build tomorrow's smart energy grid: help drives electric vehicles out of the labs and onto the world's roadways; and work to build advanced, cleaner energy production in the United States, India, China, and the Middle East at mammoth scale. Nobody else can do this like GE can.”

2. These changes illustrate one of the foundations for the management of technology and innovation: Not a single change but an organization-wide effort is needed to succeed.

A firm cannot simply decide to introduce a new technology or take advantage of a given opportunity. Instead, the company must ensure that the firm has strategies and processes in place that allow it to fit with new technologies and introduce innovations to both the organization and its people. This alignment is critical to the successful management of technology and innovation. Strategic Perspective GE is a company well into its second century of existence. The firm continues to invest in innovative initiatives, make acquisitions to enhance GE's position while divesting businesses that no longer fit the firm's strategic choices.

The firm's long-range strategy is based on four keys:

- Be global—connect locally, scale globally
- Drive innovation—lead with technology and content innovation
- Build relationships—grow customer and partner relationships worldwide Leverage strengths—use GE's size, expertise, financial capability, and brand³

The opening vignette for Part One of this paper about GE illustrates that the management of technology and innovation is not a new concern for businesses. However today, new products, processes, and approaches are emerging faster than in the past. As a result, the management of technology and innovation has been pushed to the forefront as a major focus for both business and society.

3.2.1 Importance of Technology and Innovation to Business.

To illustrate the importance of technology to business, consider the following statement by Alan Greenspan, former Chairman of the Federal Reserve.

“When historians look back at the latter half of the 1990s a decade or two hence, I suspect that they will conclude we are now living through a pivotal period in American economic history. New technologies that evolved from the cumulative innovations of the past half-century have now begun to bring about dramatic changes in the way goods and services are produced and in the way, they are distributed to final users. Those innovations, exemplified most recently by the multiplying uses of the Internet, have brought on a flood of start-up firms,

many of which claim to offer the chance to revolutionize and dominate large shares of the nation's production and distribution system.

1. Former Chairman Greenspan goes further in his speech saying that not only will the future of business be directed by technology but also that the root of business today is driven by technology and its application. His belief in the growth of technology is supported by the growth in patents worldwide. In the United States, for example, during the years 1970 1985, patent growth was relatively flat.
2. However, from 1985 to 2000, the number of patents awarded grew by more than 100 percent although they have been relatively flat since then. However, one change is that now for the first time there were more patents of foreign origin filed with the United States Patent Office.
3. At the same time, the number of lawsuits over patent rights has now doubled. Not only are innovation and technology important to the economy, but today firms believe they are clearly worth arguing and fighting over in today's business environment.

3.3 Importance of technology and innovation in business enterprise

The practical impact on the business of this growth in technology is illustrated by the fact that as recently as ten years ago information, including pricing on many different types of machinery and commodity products, was highly inefficient. It was difficult to know exactly what each firm would charge for its product and what the price would be for other firms. A businessperson could call and ask the price for that product. Whether the price was the same if you called a different salesperson in a different part of the month was not predictable. The result was that widely different prices were charged for the same products. Purchasing agents spent a lot of time looking for the best price. However, changes in telecommunications have all but eliminated this inefficiency. Internet availability has resulted in more transparent and efficient pricing for both capital goods and commodity products today.

The impact of technology on business is seldom one-dimensional, but rather, new technology causes a cascading effect within firms. To illustrate, consider the information technology from the prior example. In economic theory, we learn that price is a function of supply and demand. But the technology has resulted in both more demand and lower prices. New technology has made more information available to consumers. As more information becomes available, potential buyers become more aware of opportunities to obtain and use products. This leads to greater demand. But more precise information also leads to pricing being more systematic. Thus, technology leads to better prices. A similar cycle has taken place in other markets. Today, people use the Internet to buy automobiles, books, and other products. This has resulted in more buyers while, in many cases, exerting pressures to lower prices. For a firm to make a profit in this environment, it must be more efficient. One of the key ways that a firm obtains such efficiency is through technology. Thus, the use of technology in one domain typically leads to greater need for changes in technology in other areas. Retail is one of the oldest industries in the United States. Walmart is the world's largest retailer and is a good example of this cascading effect in practice. Today, when you purchase goods and check out at a Walmart store, you or the cashier scans the various products you are purchasing. This

process is more than a way to speed your checkout from the store. There is information generated on the sale and on the product itself. This information is used for reordering products and tracking sales patterns. Walmart wants to expand the information generated at the checkout by implementing nationwide radio frequency identification (RFID) technology. RFID technology requires a small tag be placed on each item by the manufacturer. This tag allows the product to be actively tracked from the time it leaves the manufacturer until it leaves the store. One result of this ability to track the product, Walmart will have better control of shrinkage or loss due to theft or misallocation. RFID will help the firm improve inventory control in the stores because Walmart will know instantly if there is a shortage of any given product in any given store or a surplus in another store. Walmart will be able to estimate whether the transfer of their products between stores is possible and profitable. Initially, Walmart wanted all of its suppliers to implement RFID technology. However, even Walmart found its plans to be too ambitious for the new technology WalMart missed its 2007 goals for converting its distribution centers to RFID, but is continuing to pursue the use of this technology although in a longer timeframe than initially expected. Part of the reason Walmart did not move as aggressively with RFID was that smaller suppliers protested the cost of implementing and using the technology. However, other larger suppliers like Proctor & Gamble (P&G) supported its use and has realized cost savings in implementing RFID. P&G found they are able to serve a very large customer like Walmart better and more efficiently using the technology. RFID allows P&G to obtain instant data on its products that are sold at Walmart. This in turn allows a firm like P&G to adjust its production process so that it has the supplies needed by Walmart when they are needed. It is estimated that RFID implementation could save Walmart \$8.4 billion a year in costs if it is fully deployed.

3.4 Importance of Technology and Innovation to Society

The impact of technology is not simply on individual firms. It also has broader societal impact both positive and negative. Consider the positive effect by examining the findings on the impact of technology in a single state, Washington in the USA. This state has aggressively developed its technological foundation. It has found that technology-based industries support a total of 3.55 jobs for each technology-focused job; this compares to an average of 2.86 jobs in all other industries in Washington USA. Labour income in technology-based industries averaged \$105,330 in 2015 compared to a state average of \$52,748, or 87 percent above the average. It has also been found that technology-based businesses contribute more to the state's international exports than other types of businesses. As noted before, technology helps push firms to lower costs. However, this has led to increased levels of outsourcing by a number of firms to lower cost settings; technology advances in communication and computers help ensure that such outsourcing can be successful. For example, the cost of a computer programmer in the United States can be \$90,000 a year. This same job in Russia, China, or India will cost less than half as much for the same quality work.

Technology allows many job activities to be done as easily in one part of the world as another. Thus, technology has encouraged and permitted the outsourcing of jobs to these lower cost environments to a degree not seen before. In the past, manufacturing jobs were the only jobs principally outsourced. However, today, the jobs outsourced include not only computer programmers but also other technical jobs such as reading MRI images from medical tests and preparing tax returns. In fact, Princeton economist Alan Blinder predicts that over the

next 20 years over 40 million such jobs will be lost. However, outsourcing is not all negative. Outsourcing impacts the United States as well as other developed economies like Zambia. Countries as diverse as Ireland and Korea have experienced some of the same negative impact from technology as jobs are outsourced to lower cost environments. But as one country outsources some jobs other jobs will be insourced. While individually an outsourced job may be very painful, studies indicate that there is a net 14 percent benefit to the outsourcing nation through new job creation and increased efficiencies.

In addition, the development of the economies of India, China, Russia, and other similar nations provides new markets for other businesses from developed economies. The interaction between society and technology can be viewed in terms of pushing and pulling. When we say that technology is pushing society, we mean that new innovations in technology lead to changes in society that were not expected. For example, society was not demanding the development of the Internet. However, when it became a reality, it was quickly adopted and employed. Business can also be pulled by society to create technology. For example, society demanded through their legal representatives that there be new innovations in automobiles such as more safety features and better gas mileage. The major American automakers headquartered in Detroit insisted that it would be impossible to meet those goals. However, when laws were passed demanding the innovations, business rose to the task and developed the technology necessary to meet the demands. Thus, the relationship between society and technology is rich and multidimensional.

3.4 Technology and Innovation Do Not Stand Still

Technology and innovation influence both the firm and society as a whole and this impact is ongoing. Entire industries can be created or can disappear very quickly because of new technologies. To illustrate, consider what has happened to the recorded music industry. In the last 40 years, the dominant technology has changed from records (LPs) to eight-track tapes, to cassette tapes, to compact discs. Turntables are antiques, and eight-track players are collectibles. Now with the emergence of MP-3 and other types of new technologies (4G phones), CDs and MP-3 players may soon become obsolete. Individual companies can similarly be created or can disappear quickly due to technological changes. For example, a classic American company Polaroid went into bankruptcy because of the development of the digital camera, which made many of Polaroid's products obsolete. Today, Polaroid has reinvented itself with its innovative line of Polaroid PoGo digital products, digital cameras, digital photo frames, etc. Today, the firm has become a consumer electronics company that employs a wide range of cutting-edge technologies, not a camera manufacturer. Therefore, as we begin to look at technology, we hope you recognize that technology is a key part of most businesses. Technology is typically pervasive in ways that we may not realize until we begin to explore it in depth. It is clear that an industry, firm, or individual who ignores technology and its development does so at great risk. A recent McKinsey (2015) report sums up how technology and innovation are changing how business is done as follows:

...as globalization tears down the geographic boundaries and market barriers that once kept businesses from achieving their potential, a company's ability to innovate—to tap the fresh value-creating ideas of its employees and those of its partners, customers, suppliers, and

other parties beyond its own boundaries ... has become a core driver of growth, performance, and valuation.

3.5 The study of technology, innovation, and its management

The preceding discussion illustrates that technology and innovation management are important to societies, countries, firms, and individuals. Next, we will look more closely at the various aspects of technology and innovation management.

3.5.1 The technology and innovation imperative is organization-wide

Technology and innovation influence not only the technical aspects of business but also the behaviors and attitudes of individuals and groups within the organization (White .A. H. 2011). The result is that technology and innovation are an organization-wide concern. An organization cannot isolate one unit and say its concern is technology while the rest of the organization ignores such issues.

To illustrate, the portable cell phone has become part of our everyday lives in the last decade. This technological innovation means that employees who are out of the office are not out of contact. This has made it easier to work from locations other than the office. In fact today, with applications such as wireless connection and video capability available for many cell phones and laptops, an employee may never need to be in the office. As a result, processes must be in place to ensure that the person in the field behaves as desired by the firm. This means that managers must learn how to integrate and manage these individuals differently from employees who are physically present each day. Thus, managers must not only manage changes in technology but also the structures and systems of the organization where the technology is used. This increasing complexity provides opportunities for developing innovative ways to accomplish work; it also creates the need for changes in how the firm operates.

Dr. Pepper Snapple Group

There are many other firms from mature industries that are leading examples of success in managing technological change. For example, the Dr. Pepper Snapple Group developed the Deja Blue product line. This is the most basic product imaginable: bottled water. The bottling group was able to employ technology to become the low-cost producer in the industry. Each step of the production process used all the technology possible to lower costs. None of the technological innovations is radical. For example, the production process was designed to take out curves in the production line. This reduces the number of products falling off the line. Similarly, the production process is such that the machinery that fills the bottles has ninety different heads that never have to stop. The conveyor technology when the bottle is full is at a slight angle so that the bottles stay upright as they are placed on pallets. Since 2007, Deja Blue bottles have used 35 percent less plastic than the industry standard and have begun using green ink technologies on the label. This reduces waste for society but also reduces costs for the Dr. Pepper Snapple Group.

As we examine the management of technology and innovation, we need to ensure that we not only understand how technology is developed and innovation occurs but also the processes that surround these activities in the organization. A firm needs to understand what technology it has and how to manage that technology in the organization and its context.

3.5.2 The Technological and Innovation Imperative Is Worldwide

Today, it is difficult to segment technology as being from one country or another. For example, many Taiwanese semiconductor firms have their headquarters in Taiwan, produce their chips in mainland China, but maintain their principal research facilities in the United States.⁹ Thus, technology firms are truly international entities. It is true that much of the theory, and principles, as well as the investigation of the management of innovation and technology, came from the United States and other developed countries. However, this does not limit their relevance to these countries. A theoretical foundation relevant for technology should be applicable in a wide variety of settings in management just as the theory of physics or chemistry applies anywhere in the world. For a theory to be sound, it cannot simply apply to a single nation. However, when we say that the theoretical foundation is applicable, it does not mean that there will be no differences in practice among various nations. There are many centres of excellence in technology development and application around the world.

For example, in the appliance industry, most of the world's technological developments come from Japan. Similarly, much of the new technology for portable ultrasound equipment is being developed in China by GE. Individual and firm behaviors in these centers of excellence can be expected to be somewhat different from those found in the United States; however, in most cases, the similarities with the United States are greater than the differences. The reasons there would be differences at all are due to differing institutions, or those subtle but pervasive characteristics that shape behavior. The institutions in the various domains can be described as regulatory, normative, and cognitive.¹⁰ Regulatory institutions are the laws and regulations in a given country. Normative institutions are the norms of the industry and profession. For example, the values of an accountant or a doctor are very similar around the world. Cognitive institutions are those that come from the broader society and shape the individual's behavior. Most commonly, this is viewed as the culture of the country. Regulatory institutions clearly can change from location to location. However, today, the power of the World Trade Organization and regional economic alliances such as the European Union have served to help ensure that there are some similarities in issues such as patents and other key technological concerns. The normative institutions have also developed strong similarities around the world. This strong set of normative values has emerged from a variety of sources, including the fact that many of the leading professors in technological domains around the world attended a set of key institutions, including the result has been the sharing of values these individuals learned in college. They took these values with them to diverse locations. Now they teach their own students how technological firms and professionals should act. Similarly, the increasing interaction between technological firms in different parts of the world has acted to homogenize the values of these various firms. The exchange of ideas at professional meetings and the increasing number of joint research activities have also contributed to this uniformity. The cognitive institutions are the most difficult to change and would be expected to cause the greatest difference in behavior in different organizations.

These are shaped principally by the culture of a nation. Initially, as technological firms moved internationally, some cultural conflicts did arise. However, today, such conflicts are less pervasive, and greater cultural knowledge and understanding of other nations exist. Therefore, the broad substance of the management of technology and innovation presented here will be relevant no matter where the firm is located. This does not mean that there will not be subtle differences around the world because of regulatory, cognitive, and normative institutions. However, more similarities than differences can be expected.

3.5.3 Value Creation Is the Key

Whether in the United States or elsewhere in the world, technology and innovation must add value to the firm or to society to flourish. The goal of technology and innovation processes is to add value to the business but not just for the purpose of creation. This typically means that there is a profit motive for the business or an efficiency and effectiveness motive for non-profits. Basic research, which focuses on the creation of knowledge for the sake of knowledge, can have value to society, but it is not a major concern here. In focusing on value creation, the manager must also recognize that in today's environment there is a need for technology to provide a visible and timely creation of value for the firm. Following the dot-com business crash of the mid-1990s, the spending on new technology by businesses decreased. However, this decrease must be kept in perspective. For four decades prior to the technology investment decline in the late 1990s, spending on new technology increased 10 percent annually. In 2003, that level of spending growth had declined. However, spending growth in new technology was still approximately 4 percent per year. Thus, businesses are no longer willing to invest in technology if the strategic and performance benefits of the technology are not clear. During the boom years of the 1990s, firms invested with hopes that there would be a positive result. The new competitive environment requires more in the management of technology. Now the value addition of the technology must be clear and based on sound analysis and forecasts to justify the investment. This makes the processes of the management of technology and innovation more difficult and complex. The focus on value creation has clearly been true in the turbulent economy of recent years. In 2009, the prediction was for a 4 percent increase in technology spending. However, in 2010 as the economy recovered spending is returning to historical averages closer to 10 percent. Thus, the global economy is affected by technology development and affects technology usage. Individual technology-focused firms may experience ups and downs, but the core importance of technology continues for businesses in developed economies such as the United States and the European Union, as well as emerging economies around the world.

3.7 The importance of managing technology

Now that we have defined technology and its management, what will actually be needed to build an understanding of how to do these activities? The National Task Force on Technology (2012) has listed five specific reasons individuals and organizations should be concerned about the management of technology. These reasons are as follows:

- The rapid pace of technological change demands a cross-discipline approach if economic development is to occur in an effective and efficient manner to take advantage of technological opportunities.

- The rapid pace of technological development and the increasing sophistication of consumers have shortened product life cycles. The result of these factors is a need for organizations to be more proactive in the management of technology.
- There is a need to cut product development times as well as to develop more flexibility in organizations. The lead-time from idea to market is being reduced by the emergence of new or altered technologies.
- Increasing international competition demands that organizations must maximize competitiveness by effectively using new technologies.
- As technology changes, the tools of management must change, but the process of determining what those new tools should be is in its infancy.

Each of these issues has been dealt with in this paper as we develop an understanding of how to manage technology. Although focusing on a single dimension of the management of technology may be interesting, it does not provide a useful basis to actually manage the firm. As a result, this text will address a wide range of issues and integrate those issues into a usable whole. At the heart of the various issues examined is the belief that the management of technology is the central strategic concern for the firm. If the business approaches the management of technology from this perspective, it will then have the foundation and insight to be successful.

3.8 The process of managing technology

The range of tools and issues that a firm must examine can be broad. To illustrate, consider the example of the iBOT, a new type of wheelchair that has been developed. The wheelchair has been in existence for more than 100 years, with very little change in its fundamental design. Wheelchair designs have historically confined their use to relatively flat and smooth surfaces. However, Dean Kamen, the inventor of the iBOT, saw how difficult it was for someone to handle a wheelchair in settings that were not flat, such as on stairs. So he went looking for a new solution. However, rather than thinking of a wheelchair traditionally, he sought to build a chair that could stand up and balance like a human. The end result would be a wheelchair that could carry a person up and down stairs. The development of the iBOT illustrates the role of various elements in the firm needing to work together for success. For example, the iBOT shows the need for a new approach and philosophy so that the problem could be attacked in a different way. Thus, it allows individuals in wheelchairs to roll across sand or stand to get products off the top shelf in their home or the grocery store. This case demonstrates the need not only for engineers to design the product but also for financial experts to underwrite the costs and marketing personnel to test the product. The development of this product took substantial funds and investment. Marketing was also critical to the actual acceptance of the product. While the \$29,000 cost per unit is high and its cost could be offset by the normal cost associated with modifying a house to meet the needs of a person who uses a wheelchair, it requires marketing to educate individuals about this benefit. Thus, it not only took the vision of one person to see a different solution, but it took an entire organization to develop the product. A full range of tools needs to be considered when examining the management of technology.

3.9 Making Decisions for Managing Technology

There are key decisions that need to be made as businesses and managers seek to manage technology. These decisions initially focus on the strategic posture the firm wants to assume. For example, the firm must determine if it wants to be a leader or follower in its industry. There are benefits to both, but the choice will result in the firm taking radically different steps and developing different processes and structures. The firm must also determine whether it will develop its own new technology or buy the technology. Again, each of these strategic approaches has benefits and drawbacks that will be detailed later, but the firm needs to weigh these pluses and minuses for itself. The strategic decisions do not stop there. The firm will also have to determine the scope of products it wants to offer. A key element in this determination is how it can leverage its technology and innovations to create a total platform of products and processes. The firm must also determine the scale of products, how it will price the products, where it will market the products, and where it will manufacture the products. The process that the firm needs to address each of these issues is critical. If the business responds in a reactive, piecemeal manner to the competition rather than actively determining its direction, the performance of the business will suffer. This book will examine the full range of issues with questions and key concerns for each provided throughout this book to help build an understanding of the many decisions managers must consider. The answers to the questions and the review of relevant concerns will help identify the tools that need to be employed in the decision-making processes associated with the management of technology.

3.10 Tools for Managing Technology

This perspective on the role of technology in the firm means that the specific tools necessary to properly manage technology can be very broad. Too often, managers of technology assume that, because the technology is interesting or attractive to them, it will be demanded by the consumer. However, for success, the manager does more than relying on his or her own judgment about the viability of the product. Instead, the manager needs to do things such as:

- Analyze the industry structure both domestically and internationally
- Understand the firm's capabilities and those of its competitors
- Conduct a financial analysis of the product and firm
- Forecast future changes

3.11 Definition of innovation

Now that the definition of technology and its management plus the nature of the tools and decisions related to those issues have been detailed, it is important to define innovation and its management. Innovation is part of technology management, but because of its characterization of having newness, it is unique in how it is managed and developed within a business. The management of innovation requires technology, but the management of technology does not necessarily require innovation. If the processes, products, and structure of the organization are fairly stable and the environment is mature, innovation may not be appropriate. However, managers should be alert for the opportunity to be innovative. Therefore, innovation will be treated as a separate area in this paper presentation

3.11.1 What then is innovation?

Defining innovation is not as easy as it would seem. Most of us think we know what innovation is, but we have our own frames of how to define it. Some have defined innovation as invention plus exploitation. In other words, it is not only the act of creation but the inventor or someone actually taking that product to market and selling it to people. This text goes beyond this definition to argue that innovation is more encompassing and includes the process of developing and implementing the invention. We believe that this broader definition is needed because the process elements of innovation are so critical. Thus, we prefer the definition of innovation by Rubenstein who defined innovation as “the process whereby new and improved products, processes, materials, and services are developed and transferred to a plant and/or market where they are appropriate.” It is important to note that from this definition there are different types of innovations. Figure 1.4 summarizes these types of innovations.

Figure 3.1 Innovation categories

		Product/process		
		New	old	
Old	New	Category 1 New solutions to old problems Product: new medications Process: just-in-time	Category 2 No innovation	Usage/problem
	Old	Category 3 Most innovate: new product that leads to new opportunities Product: PC in 1980 Process: bar codes for inventory control	Category 4 Old product/process used in a new way Product: other uses for a paper clip, DVDs Process: testing soil with satellite imagery	
New				

There can be the newness of the product or process, the newness of the usage, or a combination of both. The difficulty in managing these different types of innovations varies. For example, the most innovative approach is the development of a new product or process to solve a new problem or usage. These types of innovations are usually radical in their influence in change processes. For example, think about how the Internet changed how we work. Another example is the DVD, which illustrates an old process with a new usage. DVDs employ the same basic technology as CDs; however, the means of compression and reading hardware are more advanced. The examples in the prior paragraph are all product-oriented, but there are also process innovations. Just-in-time (JIT) inventory management is a process innovation that ensures the inputs into a production process are there just as they are needed for the process. Such a process innovation allows firms to save on storage and capital costs.

Frequently, product and process innovations are connected. For example, e-mail security that involves virus protection software is a product innovation. But many organizations also deal with the problems of e-mail security by building firewalls to protect company information a process innovation. It is interesting to note, however, that almost as quickly as new software and processes are developed for protecting a firm's information, new problems emerge. It is a constant war of innovation.

3.12 Definition of Management of Innovation

With innovation defined, how do we manage it? Successful innovation management depends on the top management of the organization committing resources to empower individuals and groups to act on new concepts. This commitment by the top management to innovation, in turn, requires their recognition of several realities. These realities are as follows:

- Management of technology encompasses the management of innovation.
- It requires fostering an environment where innovative thought and work are encouraged.
- It involves leading a firm from existing processes and products to something that is better and more valuable.
- It is proactive and encourages creativity and risk taking.

Therefore, we define the management of innovation as a comprehensive approach to managerial problem solving and action based on an integrative problem-solving framework, and an understanding of the linkages among innovation streams, organizational teams, and organization evolution. It is about implementation—managing politics, control, and individual resistance to change. The manager is an architect/ engineer, politician/network builder, and artist/scientist

3.12.1 The process of managing innovation

Just as for technology, there are special tools and decisions within the organization that must occur if innovation is to succeed.

3.12.2 Making Decisions for Managing Innovation

Fostering creativity is essential to managing innovation. However, it is more than encouraging individuals to think outside the proverbial box. It is a process that includes developing an environment of discovery in the organization. Delbecq and Mills (1990) described the characteristics of firms that manage the innovation process well. These firms are characterized by:

- Separate funds for innovation
- Periodic reviews of informal proposals by a group outside line management
- Clear direction on studies to be done and follow-ups that are expected
- Extensive boundary-spanning activities to learn from others and to gain an understanding of what others are doing
- Sets of realistic expectations

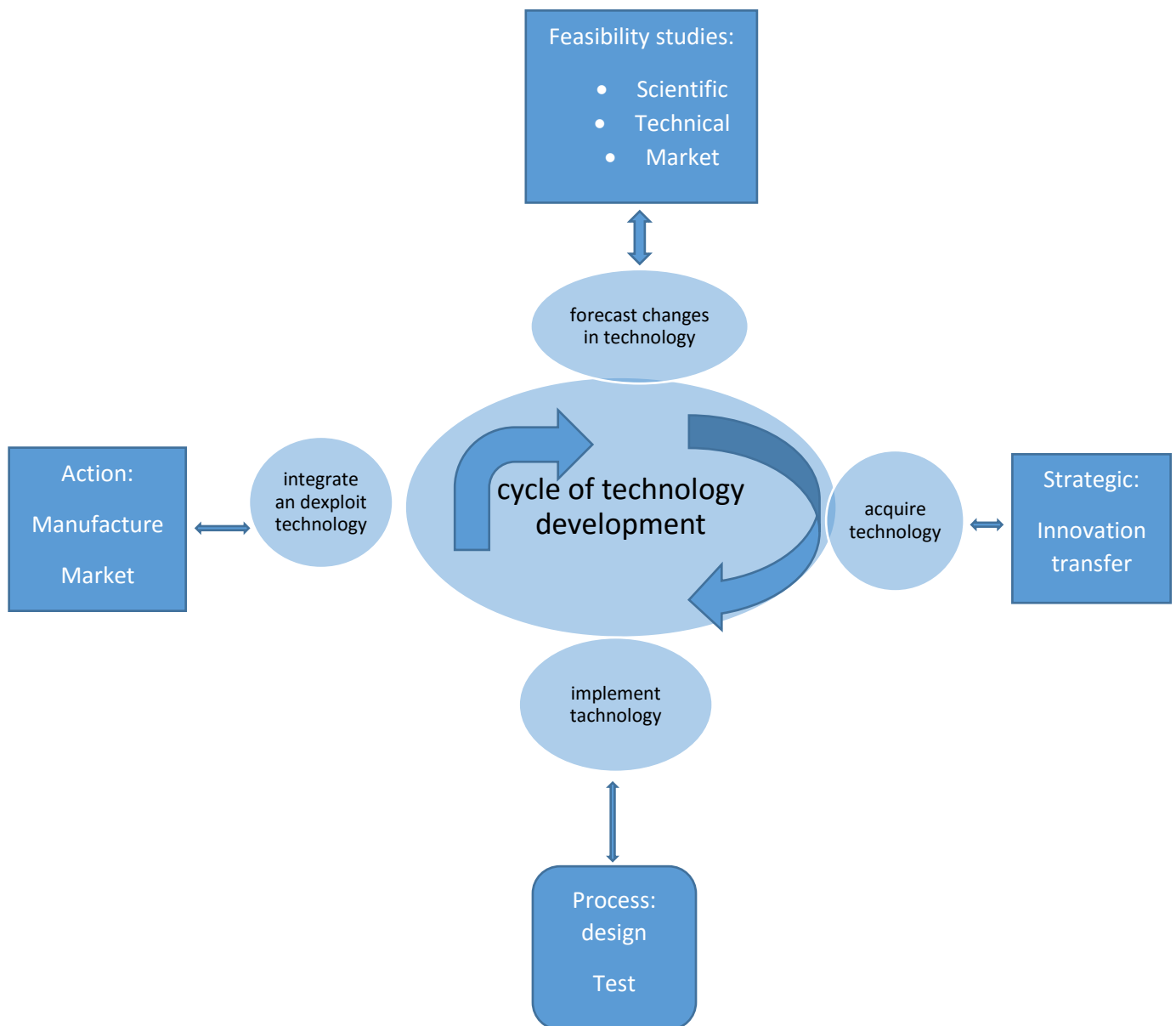
- A supportive atmosphere for debugging and exploring variations as well as appropriate resources for maintenance and service.

Pixar Animation Studios illustrates the way to build a supportive environment for innovation. This studio has created the movies Toy Story, Wall-E, Cars, and Up among others. It has pioneered the development of new computerized animation technologies, including Marionette, a software for animation, and Ringmaster, a software system for modelling, animating, and lighting. The studio has very creative individuals heading the firm (Steve Jobs, founder of Apple Computer) and others working throughout the firm. To ensure that individuals in the firm have the range of skills necessary, the business started Pixar University, which allows individuals to study for three months on a variety of topics related to Pixar's work. The company seeks to further encourage creativity by limiting its bureaucracy. Thus, the business has sought to create a total environment for creativity. The management of innovation requires that the firm encourages creativity and risk taking by individuals. The firm must employ processes that allow failure and exploration. There are four key individual characteristics that enhance the initiative that sparks innovation. If an organization manages the work environment in such a way as to encourage these behaviors, then innovation is more likely. The four behaviors are:

- Asking questions to identify problems and opportunities
- Learning new skills
- Taking risks and being proactive
- Aligning strong personal beliefs and values with the organization's values and goals

As you consider this innovation process, what becomes clear is that it should be a continuous process in the organization. It is not a process that occurs once and brings the firm all of the innovation it needs. Figure 4.5 summarizes the cyclical nature of the innovation process. The various aspects of this process will be examined in greater depth throughout the book. To illustrate this process, consider Koch Industries. The firm is one of the largest privately held companies in the United States. Koch rewards individuals for developing new ideas like many firms. But Koch also actively seeks to cross-train individuals in different areas of the firm so that they understand how the entire firm works. Additionally, the firm consciously seeks not to punish individuals if they try something new that does not work. The culture at Koch encourages risk taking. The end result is a firm that has been able to diversify from an oil and gas company into one that continually finds new markets into which it can expand.

Figure 3.5 cyclical innovation process model



Source: White et al. (2011)

3.13 Tools for Managing Innovation

The management of technology involves a much broader scope of continuing and nurturing existing technology than does innovation. Innovation directly involves the discovery and development of new products and/or processes. Most often, when we think of innovation, we think of radically new and inventive products and/or processes. For example, the innovation of the lean manufacturing system pioneered by Toyota has reshaped how manufacturers do business, with techniques such as JIT inventory now becoming the norm worldwide. However, innovation does not have to be so radical; it may be as simple as using an old product in a new way. For example, Scotch Masking Tape has been an innovation that has served 3M well since its invention in 1923. The original problem to be solved was making waterproof sandpaper. However, Richard Drew went to an auto body shop to test his ideas and discovered a need for a tape that adhered to a painted surface and stripped off easily. This innovation and the resultant technology have led to over 900 other varieties of Scotch brand tape. Successful technology and innovation management have made 3M the international corporation it is today. In this paper, we will differentiate the management of technology (MOT) and the management of innovation (MOI), but remember that they are interconnected within the organization. This differentiation helps us better analyze the firm's actions, but in reality, they are intertwined at a number of levels.

3.14 MANAGERIAL GUIDELINES

To manage its technology and innovation successfully, a firm must be proactive rather than reactive. To promote proactive approaches, a firm should:

- Designate clear technology leader's individuals who champion change;
- know how the processes can work to help and to hinder the development of new technology;
- Assess objectively where your firm is on the technology curve; Introduction (1) Strategic Management and MTI (2), Internal Innovation Planning (3) Implementation (4) Evaluation and Control (5), External Acquisition Planning (6), Implementation (7) Evaluation and Control (8), Building Capabilities for MTI Success (9), Learning and Knowledge Management (10)
- Assess the strengths and weaknesses of your personnel and your approach to the management of technology and innovation;
- Set realistic priorities;
- Develop excellent infrastructure to help find and take advantage of potential opportunities;
- Understand what the tasks are and how they are connected and disconnected;
- be systematic in your search and assessment processes, but review the system thoroughly to be sure it is still applicable;
- savor every victory and learn from every failure; and
- be confident that once you have made a decision, it is a decision that will move you in the right direction.

3.14 .1 Guiding Questions

As firms begin to lay the foundation for their management of innovation and technology, they should be guided by answering the following questions:

- Are decisions based on clear goals of where the firm wants to go?
- Do individuals recognize that being innovative and helping others be innovative are part of their job?
- Is there an environment of sharing ideas to build and develop ideas?
- Do development teams bond and truly become teams?
- How are mistakes handled? Are they seen as learning experience?
- Is risk taking prized and supported when expressing new ideas?
- Is innovation

3.15 Strategy Process and the Management of Technology and Innovation

This text integrates the strategic process perspective with the management of technology and innovation (MTI) in the firm. The foundation for the understanding of the strategic management portion of MTI is presented in this section. The specific issues addressed include:

- The meaning of strategy
- Continuous versus radical technology
- Offensive versus defensive technology
- Key MTI concerns in strategy
- The strategy process
- Understanding an industry and its impact Strategic groups within an industry

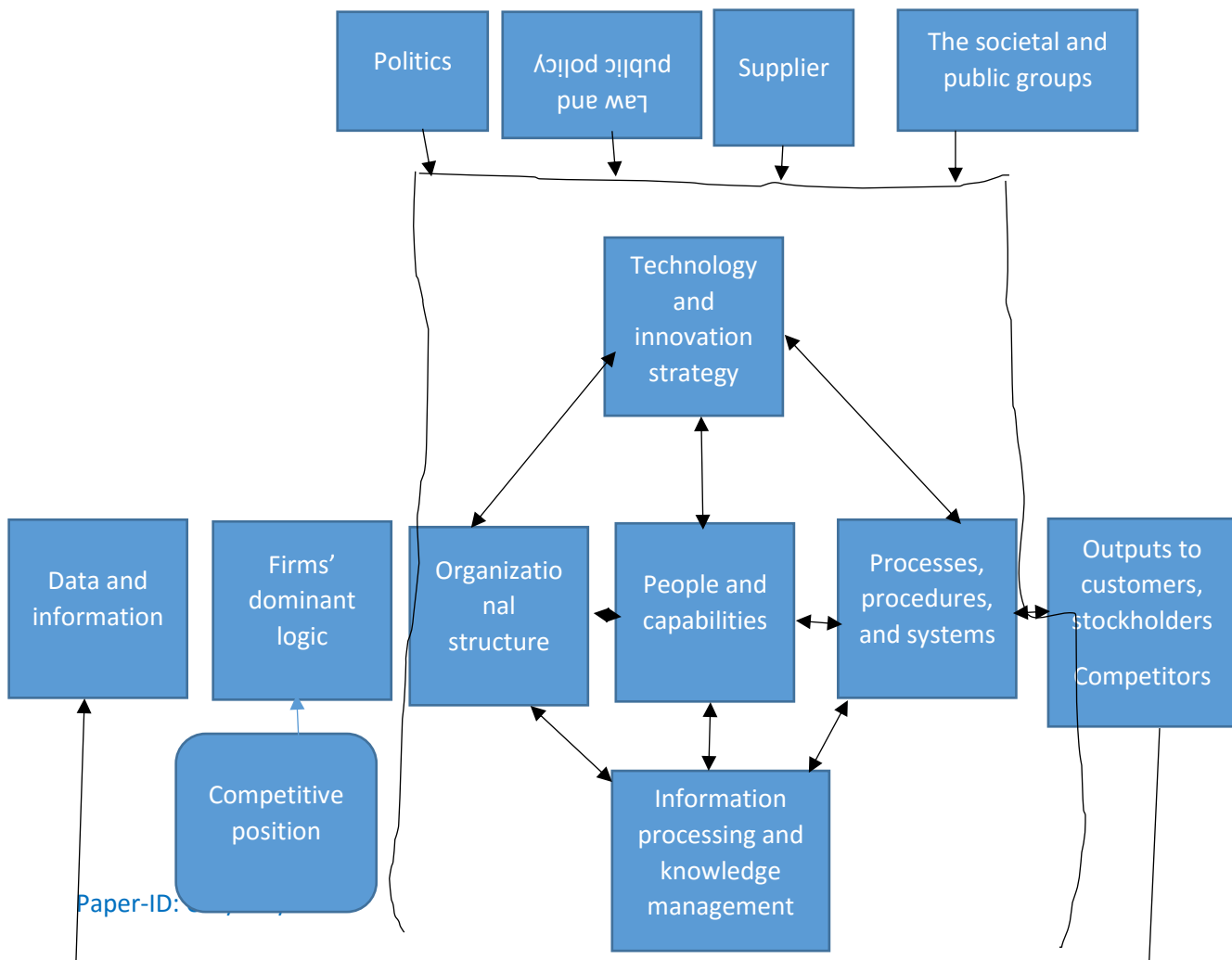
3.15.1 The meaning of strategy

The strategy is a coordinated set of actions that fulfil a firm's objectives, purposes, and goals. It is not a single act that occurs in a firm. Frequently, individuals confuse strategy with strategic planning. Strategic planning is the process that lays the groundwork and direction of the firm over the next several years. Typically, strategic planning efforts produce a formal written strategic plan. However, the strategy is more than the document that results from such planning efforts or the planning effort itself. Strategic management is an ongoing process through which the organization defines the nature of the businesses in which the firm will be active, the kind of economic and human organization it intends to be, and the nature of the contribution it intends to make to its various constituents. These broad aspects of strategy then serve as an umbrella under which the firm can establish policies and plans to ensure that its efforts are consistent and will lead to achieving its objectives, purposes, and goals. In establishing a strategy in a technology-focused firm that firm's technology is not a minor issue. Polaroid Corporation failed because its strategy and technology became separated.

The firm did not pursue the cutting-edge technology as it had historically. In fact, it was not even improving on the technology it possessed. Instead, Polaroid's strategy became focused on reducing costs to the point that it missed major changes in the marketplace. Polaroid is not unique in this behavior; there are many similar examples. Swiss watch manufacturers dominated the global watch industry for over 100 years. In the early 1960s, the Swiss did not believe anyone would be interested in digital watches. They thought a watch needed to have moving parts and a face, not just printed numbers. The Swiss firms were so sure of what watches needed to be like that they actually gave the technology for digital watches to the Japanese who then rapidly became dominant in that industry. In another example, at one time the United States steel industry was the world leader, but the United States industry generally refused to believe that air-fusion technology would impact that dominant position. The United States steel industry today is in a weak competitive position. Thus, technology is not a passive component of a firm's strategic success that should be planned, actively chosen, and constantly evaluated and adjusted as necessary.

3.15.2 Centrality of MTI in strategic management

Strategic management's benefit is critical because it helps the entire organization move toward consistent goals. Figure 4.6 shows how strategy, technology, and other organizational factors interact to determine the organization's outcomes. The resulting interactions in the figure look complex. Figure 4.6



Data be processed for the next set of potential changed

However, the fundamental point is that technology affects the strategic process in multiple places. Internally, the figure demonstrates that technology affects the organizational structure, people, processes, procedures, and systems. Additionally, external environmental factors, such as politics, the rate of innovation, laws, and public policy, all influence the interaction of people, processes, and structures. These external environmental factors also impact key stakeholders such as customers, competitors, and investors. Thus, a business clearly does not create its strategy in isolation. A business is impacted by and sometimes can impact its broader environment. Figure 4.6 appears very full, but in actual practice, there is a much richer interplay among variables than any drawing can provide.

Integrating MTI and Strategy Capabilities are skills that a firm develops. Firms are similar to their competitors in most areas detailed in Figure 2.1. Therefore, fast-food firms such as McDonald s and Burger King look very similar in many aspects. However, to be successful, there should be five or six capabilities the firm develops and maintains that are superior to its competitors. These capabilities are the building blocks for the firm s strategy. It is at the level of capabilities that the firm's integration of technology with strategic concerns should begin because the business ultimately develops its competitive advantage over other firms from its capabilities. The capabilities of a firm can be classified as either technical or market. Each type of capability is examined next.

Technical Capabilities

Technical capabilities address how the firm approaches technology it already has or wishes to have in the future. Therefore, the firm's approach to these capabilities can be classified in one of three ways: destroy, preserve, or develop. The approach to technology is a strategic decision that must be implemented through the firm's choices, including its people, structure, and processes. Destroying is concerned with eliminating certain technological capabilities in the organization and replacing them with others. Although destroying capabilities seems counterintuitive for a firm s strategy, perhaps the technology that has been employed is flawed, and improvement must take place. After the Exxon Valdez accident, many tanker companies viewed the old technology of single-hull design as too risky to continue using. Therefore, many old, still usable tankers were taken out of commission and replaced with ones with double-hull technology. The development and management of these double-hulled ships required different capabilities than did the old single hull ships. Developing new technology capabilities can give a firm a competitive leap over others in the industry by changing the playing field. These capabilities can be purchased externally or developed internally. Many firms pursue new technology capabilities to maintain or enhance their competitive position. An example of this includes retailers who pursue new Internet capabilities to complement their existing store locations, such as Sears, Walmart, and Target. Alternatively, a firm may seek to preserve its technology. In these situations, the technology

may be old, but the firm believes it still has utility. Such firms may practice continuous improvement, but they preserve some aspects of the technology. Crayolas are still a viable product even though new technologies have emerged. Binney and Smith, the makers of Crayola, have improved the product with new colours, washability, and so on, but the fundamental technology has been preserved. This has allowed the product and the firm to prosper. However, Binney and Smith also continues to seek related products and to expand their market to older children tweens with new products such as Girlfitti and Gadget Hedz. In addition, they have added Colour Wonder finger paints. The products are all tactile and experiential just like Crayola's. This continuous improvement process is part of the firm s technology strategy.

Market Capabilities

The firm must not only have direct technical capabilities; it must also have market-relevant skills that indirectly impact the technology of the firm. Engineers may develop tremendous new products but may have ignored issues such as how to distribute those products. To illustrate, a start-up medical device firm developed a product associated with hip replacement. The firm had good technology, but it could not get orthopedic surgeons to use its products. The firm could not understand why they had this problem since the company representing it and doing the marketing of the product was one of the leading distributors of orthopedic products in the country. The start-up firm realized only later that the sales representatives of the firm with which it had partnered to distribute the product focused on customers who carried orthopedic products used to treat sports injuries. Orthopedic doctors who treat sports injuries often do not perform surgery, and when they do, the standard is that the sales representative is not in the operating room. In contrast, orthopedic doctors who do hip replacement are all surgeons, and commonly have the sales representative come into the operating room and coach them through the use of a new product. The firm s failure to have sufficient market knowledge led to its decline. A fresh management team was hired to rescue the firm, and they addressed this critical difference by obtaining new distributors. Today, the start-up firm is doing well. Technological capability without market capability typically will not succeed. In summary, technology is viewed in some texts as an input to strategy but not as a central factor. The argument here is that technology should be considered a central component of the firm s strategy. In fact, technology should be considered even at the most basic level of the firm. The firm's various proficiencies must be consistent and intertwined with its technological capabilities. The firm's capabilities, including technology, provide the firm with its competitive advantage. The goal is that the competitive advantage is sustainable from the business over a significant period of time. Thus, the goal is a sustainable competitive advantage.

Technology and Competitive Advantage

A competitive advantage is what the firm does better than any of its competitors. However, the ability to perform an activity better than competitors will lead to a sustainable competitive advantage only if the activity is something that the customer's value and other firms cannot easily duplicate. To illustrate, the ability to have faster processing by computer chips can be a competitive advantage for a chip manufacturer only if there is a demand for such chips. Thus, a competitive advantage must not only be something a firm does better than its

competitors, but it must be something that impacts the customers purchasing decisions so that they buy the firm's product over its competitors' products. From such a competitive advantage, the firm can build value for its shareholders or owners. As we think of technology and competitive advantage, there are several ways to analyze technology. Specifically, technology development can be viewed as either continuous or radical; plus the technology can be used in an offensive or defensive manner. These different aspects of technology are not mutually exclusive.

Continuous versus Radical Technology

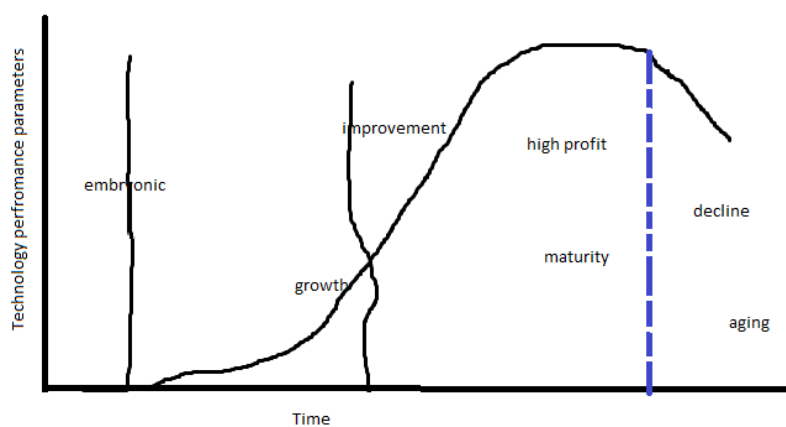
Technology development can be classified as either a continuous or radical. An example of continuous technology development is the personal computer. It seems personal computers become lighter and more mobile every year. These changes in technology are not a constant progression; instead, they happen over relatively short periods of time. Therefore, they are viewed as continuous improvements in the technology by consumers because there are no major changes that occur at one time. This progression is designed to change an existing technology but not to change its functionality. The innovation is aimed at improving performance, function, and/or quality at a lower cost. On the other hand, radical technology development causes a dramatic change in the way things are done. The initial introduction of computers altered the way information was processed and stored in organizations and by individuals. The automobile was a radical technology when introduced. It provided an extreme change in modes of transportation. No longer were individuals dependent on horses, nor were they limited to where the railroads went. In the same way, when Henry Ford took the theory of assembly lines and began using it to make automobiles, he radically changed how products were made. More recently, the smartphone has changed the way we communicate and work. For example, iPhones and BlackBerries are widely changing many industries by speeding complex information to other locations such as heart monitor information instantaneously to multiple doctors and medical centers. These radical technologies established a new functionality and a new way of doing things in business and society. Between continuous and radical technologies, a third type of technology development exists that is not often recognized. Continuous and radical technologies can be viewed as the ends of a continuum. In between on this continuum are next-generation technologies. These changes in technology and their impact on society are more than the small step experienced in continuous change, but they are not revolutionary either. For example, the personal computer is a next-generation technology from the mainframe computer, made possible by the radical innovation known as the silicon chip. Before the silicon chip, computers used tubes for connectivity and then wires and contacts. These were awkward and much less dependable than the silicon chip. As the discussion of computers illustrates, technology can be radical, next generation, and continuous at different points in time. The type of technology and innovation can also be different for various industries. Radical technology for one firm or industry may be continuous technology for another. Finally, an improvement in one industry may cause another industry to fail. The use of LED displays and silicon chips in calculators was an application of an existing technology; however, these technologies caused the discontinuance of slide rules. Continuous technological change reinforces the existing industry structure, and competitive advantage can be gained by leading the way. However, radical technological change creates new industries and alters or destroys old industries. Leading the continuous change process in the old technology when

a radical technology appears is a recipe for disaster as illustrated by our discussion of Polaroid and its missing of the digital camera revolution. A concept closely related to radical technology is a disruptive technology. There are similarities and differences between the two that are recognizable.

The concept of disruptive technology was popularized by Clayton Christensen of Harvard in his book *The Innovator's Dilemma*.⁸ This concept is similar in many respects to a radical technology because they are both technologies that change how an industry competes. However, Christensen differentiates his concept by arguing that a technology does not always have to be radical to be disruptive. Open source software is an example of a potentially disruptive technology. A low-end disruption is technology that enters the market with lower performance than the incumbent but exceeds the requirements of certain segments of that market often at a lower cost than existing products that are used by the segment. Thus, the technology disrupts that market although not a radical technology.

Maturing Process of Technology

A tool often used to examine where technological change is going is the S-curve. Initially, innovation in a domain occurs and new products and processes are introduced as firms seek to translate that innovation to the marketplace. However, typically, no single product that uses the technology in a particular way is dominant. Instead, there are competing designs that may use the same technology in different ways. It will take time for a dominant design that uses the technology in a product or process to emerge. Over time, the amount of product innovation in this domain decreases as the process innovations (structure, etc.) associated with that product improves. However, over time there are fewer product or process innovations taking place in this technology domain. The use of the technology still continues though so the top of the S declines slowly in the S-curve. The S-curve is summarized in Figure 4.7. The technology life cycle in the S-curve has four phases: embryonic, growth, maturity, and aging. The embryonic phase includes the invention and application of the invention through innovation.



Offensive versus Defensive Technology

A firm can employ technology in either an offensive or defensive manner. The firm uses an offensive technology in a way that is not being used by competitors so that it gains a competitive advantage. This advantage may come from lower costs for the firm or from providing value more effectively or efficiently to customers. For example, Sotheby's and Christie's are two of the leading auction houses in the world. These two firms have dominated the high value auctioning of art and historic artifacts. The competition between them has been fierce for decades. In the late 1990s, both firms realized that the emergence of the Internet had the potential to completely reshape their competitive landscape. The fear of the two firms was that the Internet would ultimately make their businesses irrelevant because individuals could sit in their own homes and bid worldwide over the Internet for any item. Both firms came to this realization late and tried quickly to start up Internet auction capability in the late 1990s. However, these efforts were not successful. In late 2002, Sotheby's was able to gain a competitive advantage by signing a partnership with eBay. The result today is that while Christie's has no effective effort in this area, Sotheby's is able to offer simultaneous bidding of its goods being sold at auction over the Internet. A new technology that has the potential to place Christie's at a significant disadvantage has now been effectively controlled by its competitor, Sotheby's. Alternatively, a firm can have a defensive technology and obtain technology that others already employ. The firm making the purchase in this situation feels it must employ that technology to be competitive. This use of technology will not give the firm an advantage, but it allows the business to match its competitors. Another defensive use of technology can occur when a firm acquires or employs a particular technology to block its use by others. An example of the defensive use of technology to block its use by others occurred in the wound-closure industry. Johnson & Johnson, through its Ethicon subsidiary, in 1999 was the world's largest provider of surgical staples, stitches, and special-purpose wound bandages for major surgery. However, Closure Medical Corporation patented a completely new technology for the closure of wounds in 1999. The firm's Derma Bond product was developed to glue the skin back together. The technology had the potential to make most of Johnson & Johnson's wound-closure products irrelevant. As a result, Johnson & Johnson sought out and obtained a marketing agreement with Closure Medical Corporation. Johnson & Johnson realized that its Ethicon unit was at a competitive disadvantage after Closure Medical developed its new technology. However, rather than ignore the change, the firm sought out the means to gain some benefit from the presence of the technology in the market. Johnson & Johnson would profit more if it owned the new technology, but Johnson & Johnson did not and could not ignore the new technology. Recall that Polaroid did ignore a new technology in its industry and failed. Therefore, Johnson & Johnson sought to be a part of this new technology through obtaining a license for it.

2.0 Methodology

The methodology and approach that was used developing this paper were literature review by way of document reviews, accessing online technology journals, and offline publications, and Delphi method by way of expert opinion on technology and innovation management, industry captains on technology, scientists and manager of technology mainly in

Lusaka.Engineering Institute of Zambia was deliberately targeted to sample 5 key personnel from its database of the members mainly fellows who are involved in the management of innovation and technology.

3.0 Result presentation and conclusion

The ultimate goal of a technology-focused firm, whether it seeks to obtain technology internally or externally, is to create value for the firm and the firm's stakeholders. The best way for a firm to create value that will continue over time is through a sustainable competitive advantage. The foundations for this sustainable competitive advantage come from the capabilities of the firm especially state of art technology and innovation and creativity process. A literature review has shown that technology can create a competitive advantage that can be sustainable over time. This paper has highlighted the importance of technology and innovation the following key issues concerning technology and innovation management were addressed in this paper: concepts of technology and innovation management, systematic view of an organization and its management of technology, significance of technology to the commercial organization and society, the tools of technology and innovation management

6.0 Recommendations

a firm must be proactive rather than reactive. To promote proactive approaches, a firm should:

- Designate clear technology leader's individuals who champion change;
- know how the processes can work to help and to hinder the development of new technology;
- Assess objectively where your firm is on the technology curve; Introduction (1) Strategic Management and MTI (2). Internal Innovation Planning (3) Implementation (4) Evaluation and Control (5), External Acquisition Planning (6), Implementation (7) Evaluation and Control (8), Building Capabilities for MTI Success (9), Learning and Knowledge Management (10)
- Assess the strengths and weaknesses of your personnel and your approach to the management of technology and innovation;
- Set realistic priorities;
- Develop excellent infrastructure to help find and take advantage of potential opportunities;
- Understand what the tasks are and how they are connected and disconnected;
- be systematic in your search and assessment processes, but review the system thoroughly to be sure it is still applicable;
- be a savior of every victory and learn from every failure; and
- be confident that once you have made a decision, it is a decision that will move you in the right direction.

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