Using a New Lens to Examine the Dynamics of Typewriter and Vending Machine Industries

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Abstract

Given the fact that our understanding towards innovation life cycle has been mainly confined to a framework called "A-U model", which was developed by Abenarthy and Utterback in the 1970s, this paper aims to update our knowledge on the dynamics of industry by introducing a new innovation trinity life cycle model, and demonstrating the usage of the model in two industries.

Keywords: Innovation Trinity, innovation life cycle, the typewriter industry, the vending machine industry

1. Introduction

A feature of previous innovation studies is to use a dichotomy as a gateway for entering innovation domain. It means that innovation has always been treated as a combination of two things or two parts. The A-U model is a typical application of the innovation dichotomy. By using production innovation and process innovation as two basic building blocks, the A-U model displays four stages in the life time of an industry: the introduction or fluid phase, the growth or transitional phase, the mature or specific phase, and the decline phase. The hallmark of the A-U model is dominant design and associated standardization, which not only emphasizes the roles of process and incremental innovations, but also points out the linkage between dominant design and the shift of innovation priority. As the popularity of the A-U model grows, more concerns about the model and its limitations have been aired. Critics are in several aspects including exclusion of business innovations, simplification and insufficient sorting function (Lan 2009).

Breaking away from the traditional innovation dichotomy, a more accommodative gateway titled "innovation trinity" was developed (Lan 2009, 2010, 2013). The innovation trinity means that a common denominator of innovation is consisted of three basic types of innovations: functionality, delivery and relationship innovation. Each individual part of the innovation has a unique value proposition, plays a distinguished role and show different temporal dynamics. The interaction of the innovation trinity forms a unique platform for dealing with various issues of innovation. As a component of the innovation trinity, a seven-stage innovation chain with certain sustaining loops has been introduced (Lan 2009, 2010).

This paper employs those concepts to both the typewriter industry and the vending machine industry. The two industries present two different scenarios. The former brought about a brand new device with special functionality in the 1860s. It penetrated into every corner of the office and many households in the western world. After existing over a century, the whole industry was wiped out by personal computers beginning in the 1980s. The latter started around 1880s. After experiencing over a hundred year's up-and-down, the industry is still evolving.

The examination finds out that although the two industries display distinguished development paths, the configuration of a seven-stage innovation chain with certain sustaining loops of the new model provides a useful means for better understanding the dynamics of an industry.

This paper is organized as follows. Section two explains the concepts of innovation trinity and "chain-loop" innovation life cycle model. Section three traces the century long history of the typewriter industry from cradle to grave. Section four analyzes the development of the vending machine industry. The final section summarizes the application of the "chain-loop" innovation life cycle model in the two industries research and discusses their implications.

2. A "Chain-Loop" Model Based on Innovation Trinity

The popular A-U model, developed by Abernathy and Utterback in the 1970s, is a typical application of innovation dichotomy.

It uses production innovation and process innovation as two basic building blocks to explore dynamics of an industry. Based on the dichotomy configuration, it specifies four stages in the life time of an industry: the introduction or fluid phase, the growth or transitional phase, the mature or specific phase, and the decline phase (Utterback 1994). As the popularity of the A-U model grows, more concerns about the model and its limitations have been aired. Critics include exclusion of business innovations, simplification and insufficient sorting function (DeBressonand Lampel1985, Teece 1986, Keating 2004, Lan 2009).

Innovation Trinity

Breaking away from the dichotomy tradition, Lan (2009, 2010, 2013) developed a more accommodative gateway titled "innovation trinity", which expand innovation domain from two-dimension to three-dimension. The innovation trinity means that a common denominator of innovation is consisted of three basic types of innovations: functionality, delivery and relationship innovation.

Functionality/product innovation (F) focuses on creating or improving products and services that demonstrate certain usefulness and utility. Functionality can be administered in both products and services. For example, coffee beans are used to make coffee and espresso drinks that provide caffeine for people to start their day. Coffee product's functionality in this case is to provide extra energy to the drinker. Coffee shops are an example where functionality is embedded in both tangible goods and intangible service. According to Lan (2009, 2010, 2013), several features are related to functionality innovation. Firstly, having a new product or service creates an outlet to display the creation of new concepts. At the same time, the product or service determines the goal of a firm and helps to define its relationship to the outside world. Secondly, the creation of functionality results from knowledge advancement and dissipation and causes an upward shift of a demand curve. In functionality innovation, research, development, and engineer activities play more prominent and distinct roles. Thirdly, functionality innovation can have several ups and downs throughout its life cycle measured by introducing or improving functionalities. One peak may be related to the introduction of new functionalities embedded within a new product or a service. Another peak may correspond to diversification of functionality, which witness the branching of a product into a product family. The third peak may be related to the replacement of the functionalities and their embedded products or services. The surviving pressure motivates more product regeneration efforts

Delivery/process innovation (D) focuses on forming new or improved processes/methods, which is always demonstrating the gained efficiency in the process to obtain the utility in question. Lan (2009, 2010, 2013) identifies the following characteristics related to delivery innovation. Firstly, in manufacturing arenas, internal oriented technical changes and the rational organization are set as the default for process innovation. In the service arena, both internal and external delivery improvements are set as the default for process innovation. Secondly, delivery innovation demonstrates greater variety in openness. At one extreme, it may be more transparent to others, since some process innovation can be purchased from the outside sources, which are also available to competitors. At the other extreme, it may be more obscure since whole process can be developed by the innovator internally with little disclosure to the outside world. Thirdly, delivery innovations are common in mature industries and are tending to bring substantial financial gains to innovators. Fourthly, more than one innovation peak can be identified through tracing the delivery innovation efforts. One peak may come after introducing new product or service with an emphasis on refining production or delivery activities, providing special equipment or facilities, and standardizing or automating operating systems. Other peaks may correspond to the significant modification and replacement of functionalities.

Relationship/business innovation (R) is a collection of sub-innovations that focuses on establishing a new or improved relationship for creating business value generated from the utility and delivery. Delivery innovation can be defined as residual of functionality and delivery innovation, sum of strategic innovations, market innovation, organizational or administrative innovation, and management innovation. When an organization improves its inside and outside relationships, it becomes capable of selling desired results, not just products. Some companies attribute their success to business innovation instead of product innovation and process innovation.

Some service companies such as AT&T and Expedia have outsourced their employees, which was an innovative way to reduce business cost, back when employee outsourcing was a new thing.

According to Lan (2009, 2010, 2013), relationship innovation displays (1) deeper and wider social roots and can be conducted by anyone in a society with entrepreneurial spirit; (2) three peaks corresponding to the birth pulse, mid-life pulse, and death pulse of a given entity; (3) more evenly distributed alone the timeline than functionality and delivery innovation; (4) a larger role in explaining the evolution of an industry due to its ubiquities and natural overlap with other two types of innovations.

Seven-Stage Innovation Life Cycle

Based on the definition of the tripartite of innovation—each individual part of the has a unique value proposition, plays a distinguished role and show different temporal dynamics, Lan (2009, 2010, 2013) further identifies seven statuses or basic patterns of innovation (F, D, R, F+D, F+R, D+R, F+D+R), because there are only seven meaningful combinations of the three components. The F status corresponds to radical innovation of previous studies. The D status related to incremental innovation. The R status is defined as engagement innovation. The F+R status is defined as dual-core innovation. The D+R status is set as restructure innovation. The D+F status is stated as dichotomy innovation. The F+R+D status is described as cross innovation.

In addition to identifying the seven basic status or patterns of innovation, Lan arranged those status into a temporal sequence and formed a seven-stage innovation chain. The starting stage of the innovation chain is radical innovation, which involves creating new functionalities which results from new methods and materials that are novel to the innovators and others (Schumpeter 1939), and results in new products or services. The novel methods and materials are derived from either an entirely different knowledge base or from a combination of parts of an established knowledge base with a new stream of knowledge (Freeman 1982). Because the creation of new functionality needs time and commitment (Verloop 2004), and requires repeated accumulation of necessary knowledge (Arrow 1962), only limited organizations have the opportunities to commercialize it in an uncertain environment. This phase usually starts with a prototype and ends with a commercial product.

The second stage is dual-core innovation, which means both functionality/product and relationship/business innovation are crucial. In this stage, establishing a consumer beachhead for the product or service is the goal for innovators. To move forward, they have to align the new or refined functionality with possible new or unmet consumption (Christensen and Raynor 2003), since only new consumption can prove the usefulness of a new functionality. Stimulated by the pioneers, more ventures will be formed based on the spread of know-how. Winners in this stage are innovators who successfully combine product innovation and business innovation instead of being technology champions alone (Teece 1986). As Chesbrough (2003) mentioned, unless someone knows the most valuable uses of a technology and the best markets to target, the technology superiority is difficult to realize. At this period, successful innovators, on the one hand, create a new business model to posit the new functionality to the unfamiliar environment with a very different value proposition (Christensen 1997). On the other hand, they develop the new functionality to fit the new environment (Gaynor 2002, Verloop 2004).

The third stage is cross-over innovation, which means that all three types of innovation—functionality/product, delivery/process, and relationship/business innovation—are active. The establishment of a consumer beachhead stimulates more players in the domain and triggers various innovations. In this crossing innovation stage, new functionality spreads quickly. Invention and innovation related to the usage of the new functionality are pervasive. Merging and acquisition are widely used to access special know-how or to enter the market via a fast track. While the boundary of the industry domain is enlarging, a new business or social platform is emerging too, which changes many aspects of operations in a short period (Lan 2006). This enlargement means that a new fashion is spreading rapidly. Innovation winners in this stage are not necessarily the pioneers. Any participant who contributes to designing a widely acceptable product or service, sets a sound infrastructure, or organize an effective interface can win out (Tuppura 2009). In this way, advantages of early followers can be secured, because the knowledge base for innovation is much larger than before (Chesbrough 2003). When innovators act in the crossing innovation stage, they expect to become a key builder or part of a key team of builders which build the new operation platform within the new domain (Shapiro and Varian 1999, Sawhney and Prandlli 2001, Cusumano and Gawer 2002, Iyer and Davenport 2008).

The fourth stage is incremental innovation, in which delivery/ process innovation is more active after an influential design is established on a new operation platform. In this stage, innovation is defined comparatively clearer, and it builds mainly on the established knowledge base (Utterback 1994).

The priorities of innovation are introducing relatively minor but persistent changes to the existing products or services, exploiting the potential of the established design, and processing methods or used materials (Freeman 1982). Also, standardization and automation of product or service is achieved through vertical invention, which not only raises the threshold for new-comers, but also reinforces the dominance of established firms (Nelson and Winter 1982). The incremental innovation stage is regarded as a golden age for both innovation winners and users of new functionality, because the gains in productivity are substantial (Abernathy 1978, Henderson and Clark 1990). However, this stage could also witness sustaining innovation "over shooting" itself to become a "tyranny of success" (Christensen 1997). When innovators compete in the incremental innovation stage, they expect to become a new rhythm setter within the new operation platform for finding an optimal routine.

The fifth stage is restructuring innovation, in which delivery and relationship innovations are dominant. After the declining of innovation during the incremental stage, restructuring innovation represents the second peak in an innovation life cycle. Several factors could contribute to the rising of the innovation curve. First, modification of certain features of the influential design could be made. Secondly, modulated production or delivery of the new functionality is possible due to vertical and horizontal invention surrounding the new functionality in the previous stage (DeBresson and Lampel 1985, Henderson and Clark 1990, Verloop 2004) or an innovation "long tail"—a jump of innovation over a period of steady moving (Fleming 2007). Thirdly, the enhancement of influential design over a period of time could marginalize certain segments of consumers (Cusumano and Gawer 2002) through technological overshooting (Christensen 1997), which leaves room for low-cost disruptive innovation (Christensen and Raynor 2003). Fourthly, the interaction of architectural and disruptive innovations is often embedded in or results in enterprises' mid life crisis, which requires more business innovation to recover (Sull and Houlder 2006). The restructuring of innovation opens doors for new comers or late entrants, because they can use their know-how to respond to customer demands, to improve modules or components, and to use system integration as a winning ticket. When innovators contend in this stage, most of them do not aim at totally changing the functionality of a product or a service. They expect to change the delivery and/or certain features of the product or service, as Underwood did by introducing a new typewriter; GM offered more choices for automobile customers; Cannon entered the photocopy machine market with a simpler machine (Christensen 1997); and Google developed a better online search engine (Lan et al. 2007).

The sixth stage is engaging innovation, in which relationship innovation is the focus. In this stage, stagnant or declining demands for the products or services can be observed from decreasing operation margins, particularly decreasing returns on modifying the product or service. Facing the surviving challenges, innovators expect that new business deals could help them to reverse the trend within their domain. Various business innovations, therefore, are aiming for adjusting or optimizing linkages set up before. To gain high efficiency, innovators broaden their learning channels and conduct a wide range of activities with leveraging purpose. Their initiatives could include partnering with customers and engaging them as innovators (Von Hippel 1999, Thomke and von Hippel 2002), having more M&A and getting more stimulation (Roberts and Liu 2001), changing personnel frequently with some outsiders on board (Sutton 2002), or soliciting other supports and their knowledge from suppliers, universities, national labs, consortia, consultants, and others (Chesbrough 2003), or changing the location/boundary of physical operations. One feature of this stage is that few new comers will enter the market. In the case of typewriter industry, no substantial manufacturer entered the market during this period.

The seventh or the last stage is dichotomy innovation, in which functionality and delivery innovation are not only active, but also tied together. In this stage, the overall market for products or services may be shrinking, and operation margins may be diminished due to overall environment change. Technology for generating original functionalities may be in perfect shape, but the original functionalities are no longer desirable. Under this situation, an innovation dichotomy happens. On one hand, many players exit the industry with most selecting a fast-track. On the other hand, some players tend to embrace a new product or service, which has either a similar functionality with a different enabling system, or a brand new functionality. Most innovators who hang on in the industry have faith in scientific advancement or the nature of cyclic development. They expect to go through the tunnel of small outlets and bet that either something will grow big, or that the environment will favor similar functionalities again in the future.

As a feature of innovation at this stage, R&D ratios and innovation orientation show substantial changes. R&D ratios may be higher, due to other expenditure cuts, or lower, due to the phasing out of innovation. Innovation orientation shows an internal shift. More innovation efforts are concentrating on comparatively closed experiments or highly selected technology transfers.

To do so, industry-wide innovation on both product and process may be raised again. However, functionality and delivery innovation will be less interdependent (DeBresson and Lampel 1985), because the linkage between them becomes vague, and either can be a spring board for entering a new domain. In this situation, innovators may even pursue a set of potentially conflicting paths at the same time (Sawhney and Prandelli 2000).

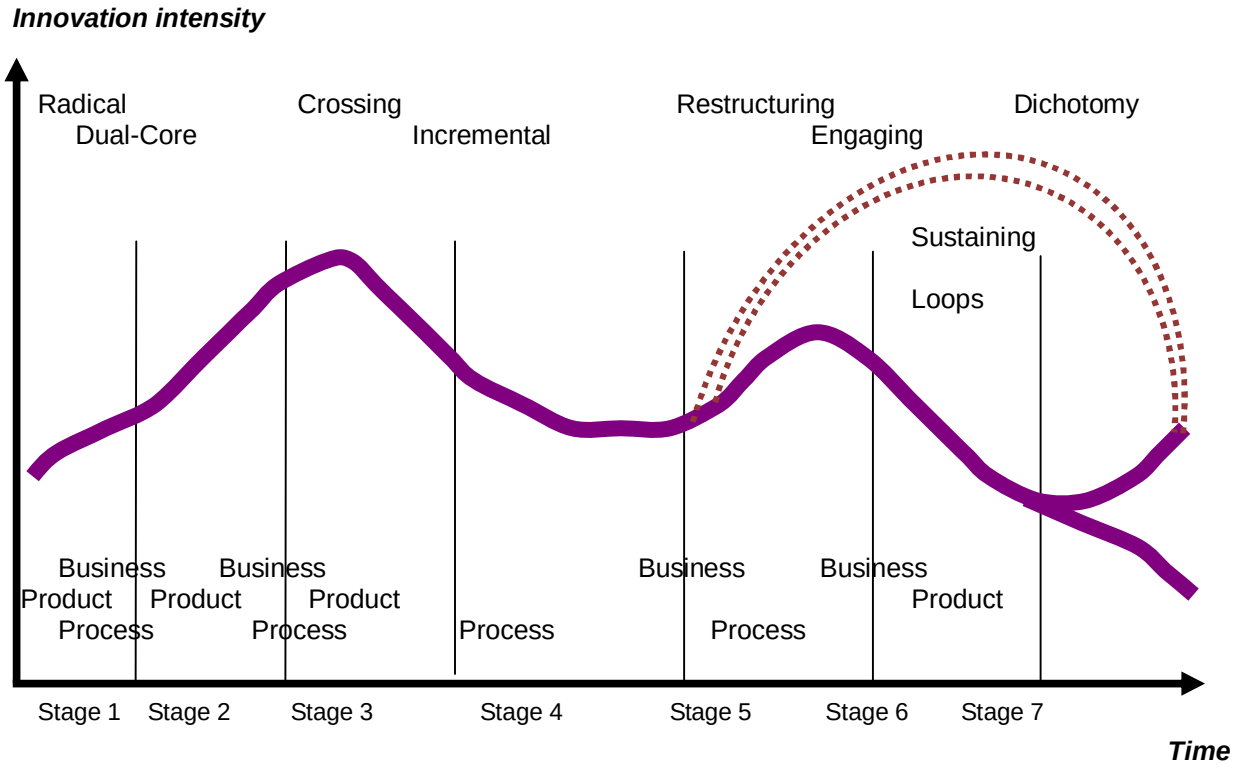
Sustaining Loop

Traditionally, studies on innovation life cycle treat any new technology change within an industry as a new innovation life cycle. For example, the developments of the manual typewriter, the electronic-powered typewriter and the stand-alone word processor were treated as distinct innovation life cycles (Untteback 1994). Different sized disk storage devices were also treated as having their own innovation life cycles (Christensen 1997). This approach, on the one hand, increases the complexity of an industry analysis, which easily confuses both researcher and practitioners. On the other hand, it often cuts off the relationship between technologies and stakeholders within the industry.

Lan (2009, 2010, 2013) argues that many technological progresses occurred in the dichotomy innovation stage, which do not create a new or different functionality, and thus will not initiate a new innovation life cycle. Therefore, it will not go through the stages of radical innovation, due-core innovation, and incremental innovation. Instead, it will directly go to the restructuring innovation stage within the original 7-stage innovation chain, and form a three-stage development loop, i.e. restructuring-engaging-dichotomy innovation loop. In each loop, it did not create a dramatically different function. Therefore, it did not change the paradigm of the industry, although it did change the features of provided products and caused the reshuffling of industry. However, when a totally different product or service with a much broader functionality appears, the introduction of the product will not only toll the knell of the old products, but also open the door for a new industry.

Combining the 7-stage innovation chain and sustaining loop(s), a “chain-loop” innovation life cycle model is developed from the innovation trinity as shown in Figure 1. The next two sections will apply the model in two industries.

Figure 1: Chain-Loop Model of Innovation Dynamics



3.Case of the Typewriter Industry

Typewriter became a product (1868-1874). According to Acocella (2007), a mechanical device, which could help human beings' writing, was invented over 50 times in history. Among them, Christopher Latham Sholes's invention stood out. In 1868, Sholes patented his typewriter. The Sholes's typewriter consolidated some technologies from other devices: the escapement—i.e. moving the carriage one letter at a time is from clockwork. The keys and their connecting arms were adaptations of the telegraph key. A sewing machine pedal returned the carriage, and the piano suggested a model for the free-swinging arms and hammers that struck the letter to the paper. Urged by his business partner, James Dunsmore, Sholes made a succession of some 50 models—each one reflecting some minor improvement—of his crude device. Functionality or usage of the device has been the focus of Sholes' efforts.

During this time, Remington Company had been trying to diversify into other areas with the boom times of the Civil War behind it. The idea of a typewriter appealed to Philo Remington, the president, and his associates. Their plant in Ilion, New York was underutilized, and they wanted to expand their line of consumer products. In 1873 Remington started to perfect the machine for production in a section of its Ilion plant and in July 1874, Remington No.1 were in stores across the country. No.1 could produce up to 75 words per minutes in the hands of an expert typist, while a good writer with a pen could not do more than 30 words per minute. The sales of the No.1 were slow. Impeded by its high price and poor performance, Remington managed to sell only 400 units during the first six months by the end 1874 (Lan 2013).

Typewriter got a consumer beachhead (1875-1880). After launching and Remington No.1 typewriter, Remington made continuous improvement on its typewriters. In 1878, the company introduced the No.2, with the double typeface and a shift key. The result is that each typebar could type two different characters, cutting the number of keys and typebar in half and simplifying the internal mechanisms considerably. The use of the shift key was to allow letter keys to type both upper and lower case. It allowed number keys to accommodate special symbols such as percentage (%) and ampersand (&).

With the shift key, typists' operations were simplified. Also during this period, Remington's marketing campaign revealed a unique selling point "persons travelling by sea can writer with it when pen writing is impossible". It defines typewriter as "A Machine to Supersede the Pen". *The Typewriter Magazine*, the first journal to support and record the advances of the industry was launched in 1877. The breakthroughs in manufacturing and marketing enabled Remington to engage many celebrities for demonstrating that old methods of writing in newsrooms, offices, and homes gave way to typewriting. From 1875-1877 Remington sold 3,600 machines. Yost Caligraph, a cheap version of the Sholes machines was offered by the former sales agent of Remington (Lan 2013).

Typewriter became a fashion (1881-1888). In 1881, the Caligraph No. 2 came on the market with upper and lowercase function; but unlike the Remington, the Caligraph did not use a shift key—it had two entirely separate keyboards. In 1885, the Crandell, the Hammond and the Hall machines appeared—each based on a uniquely different design for striking type to paper. By the end of the period, a torrent of new competitors had entered the field. In 1886, *Scientific American* estimated that 50,000 typewriters of all makes had been produced. Mark Twain delivered the first typewritten manuscript—*Life on the Mississippi*—to his publisher. The book was published in 1883, and others quickly followed suit. By 1888, Remington alone produced 18,000 typewriters. Its Ilion plant had adopted mass-production techniques to reach this level. Specialized departments performed the die-casting, tempering, forging, annealing, plating and assembly operations. Specialized equipment was developed and brought on line, and skilled workers assembled each machine individually. Also, a highly publicized "$1,000 challenge" was held in Cincinnati in July 1888 with Remington and Caligraph competing for the fastest machine. Caligraph was soundly thrashed (Utterback 1994).

The wide spread of the typewriter made typing a fashion. In 1887, it was said that "its monotonous click can be heard in almost every well-regulated business establishment in the country." Typewriters became ubiquitous fixtures in the workplace. The demand for typists permanently changed the dominance of males in office. Traditionally, in offices men ruled the bastion. With typewriters, women were now let in. At $15 per week in 1886, the typist's pay was far better than what could have been earned in the factory or the retail shop, and the working environment for women was said to be much better. People argued that typewriters did for the office what automated equipment did for the mill—it separated thinking from doing.
Now the manager could do all the thinking, and the typist could manually transcribe those thoughts into documents. The burgeoning of both typewriters and typists were an indicator that a new paradigm was emerging (Lan 2013).

Typewriter demonstrated a consolidated rapid growth (1889-1894). The public victory of Remington enabled its design of a typewriter to become an influential design. Among them several elements are important. The first one is the "key-keybar-striking head-carriage return" working mechanism, which determined the basic architecture of a typewriter. The second one is its QWERTY keyboard layout, which determined the interface of the device and typists. The third one is its "shift" key function, which simplified internal structure of the typewriters. Although there were variations from one manufacture to another, the design of all manufacturers were convergent around those elements. The standardization helped the growth of typewriter industry. A community of typewriter manufactures and several dozens of their suppliers faced an exploded market. In 1890, they employed 1,800 people and produced $3.6 million in finished goods sales (Lan 2013).

Typewriter manufactures were reshuffled (1895-1908). In 1895, John T. Underwood and his father, who were in the ribbon and carbon business, entered the field with a new product, the Underwood No.1. This machine has an important new feature: visible type. This machine changed type arms and made them swing out and strike the paper front and center, where the operator could observe any mistake and correct it immediately. This feature is different from all old typewriters, in which typists can only see what they typed after four rows. The Underwood No. 1 was an immediate success, and was followed in short order by several models that refined its basic design. The most important of which was the Model 5 which had the look and feel of the modern manual typewriter that anyone could feel comfortable with. The Underwood also shifted its production to a large factory in Hartford, Connecticut. With its market leadership decimated by the new challenger, Remington rushed out its Monarch model in 1901. L. C. Smith & Brothers—another big producer—followed with its No. 8 in 1908. In 1904, the Royal Company entered the typewriter field. It was regarded as the last of the new entrants to gain any real standing. By the end of this period, over 80 manufacturers had tried their luck in the American market. However, only Underwood, Remington, Royal and L.C. Smith & Brothers were able to dominant the American market (Utterback 1994).

Underwood beat Remington and became the No. 1 typewriter manufacturer due to its improvement on the design for the typewriter. The same as Underwood, *Typewriter Topic*, a journal dedicated to document the evolution and advances of the typewriter industry, was launched in 1905. It beat *the Typewriter Magazine*, the first journal of the typewriter industry launched in 1877, and became the foremost popular periodical enjoying a circulation of nearly 13,000 by 1908 (Linoff 2000).

Typewriter manufacturers' competition was intensified (1909-1929). In this period, the demand for both typewriters and typists changed. Overall market for the product was stagnant. For example, two indicators which demonstrated the increase of typists became saturated in the 1910s; one is the lower increasing rates. The other is the percentage of women in all typists, which reached 92 percent in the 1920 (Engler 1970). Given the stagnation and decreasing of the market, all typewriter manufacturers tried hard to shore up their sales. During this process, the pattern of the industry showed little change. By 1920, Underwood had a lock on the business, selling as many machines as all of its rivals combined (Engler 1970).

Typewriter manufacturers' dichotomy (1930-1990s). The 1930s were not good years for the typewriter industry. The Great Depression decimated economic growth, and with it, expenditures for office equipment. Of the four leaders, only Royal had a very limited positive growth rate. Many firms were leaving the business. In 1930s, the survivors and newcomers moved to another path—manufacturing electric-powered typewriters. Stand-alone word processor started in the 1960s. The expansion of the typewriter industry and its fading out could be divided into the following three loops:

Loop 1: electric-powered typewriters were introduced and burgeoned (1933-1936). In 1933, International Business Machines (IBM) purchased a fringe player in the typewriter industry—Electrostatic Typewriters, Inc and became a newcomer of the industry. The closest business of IBM related to typewriter at that time was record-accounting and tabulating machines. Neither Underwood nor Remington had shown interest to buy Electrostatic Typewriters, because both of them had disappointing experiences with electric-powered typewriters in the 1920.

Since electric-powered typewriter did not change the key functionality of a manual typewriter, it did not represent a radical innovation. However, it did provide better performances: more uniform print, better quality copies, and less physical stress in the typists over long periods. The 1933 purchase gave IBM years of design and manufacturing experience that put it well along the learning curve. IBM's role in the typewrite industry growing with the replacement of manual typewriters by electric-powered typewriters. By the end of this period, electric-powered typewriters had about 64 percent of total office/nonoffice market, and IBM produced over half the electric-powered typewriters. The other major typewriter manufacturers such as SCM, Royal, and Underwood each had about 10 percent of market share. Remington was barely on the map (Engler 1970).

Loop 2: word processors were introduced and burgeoned (1964-1976). Differing from electric-powered typewriters which were introduced during a depressed economy, stand-alone "word processors" were introduced due to digital computing technology. Word processors are a type of stand-alone office machine combining the keyboard text-entry and printing functions of an electric typewriter with a dedicated processor for the editing of text. Although features and design varied between manufacturers and models, with new features added as technology advanced, word processors for several years usually featured a monochrome display and the ability to save documents on memory cards or diskettes. Later models introduced innovations such as spell-checking programs, increased formatting options, and dot-matrix printing. This association did not change the basic function of typing, but put the function in a broader background.

It was IBM that first moved into this area by introducing the IBM Magnetic Tape Selectric in 1964, which made text editing possible for the first time. Wang, Xerox, Exxon, ITT, AT&T, Olivetti and over fifty others companies followed suit. Each company invested heavily in developing elaborate and expensive systems that intended to do for text processing what henry Ford had done for auto assembly. For example, Exxon alone spent an estimated $2 billion on its office equipment division. During this period, the Canadian company Automatic Electronic Systems (AES), introduced the world's first programmable word processor with a video screen. Their machine stored the operator's texts on magnetic disks. Texts could be retrieved from the disks simply by entering their names at the keyboard. Wang laboratories introduced a "Glossary" function in its machine. By 1975, some 200,000 word-processing devices had been installed (Untterback 1994). The top two word processor manufacturers were IBM and Wang Laboratories by the end of this period (Thomas 1983).

However, the electronic office proved not to be the factory of the future. The millions spent on word processors could not be shown to generate much productivity improvement, and the word-processor firms took big losses (Untterback 1994).

Loop 3: typewriters were wiped out (1977-1990s). The whole typewriter industry, including manual typewriters, electronic-power typewriters and stand-alone word-processors faced a huge challenge later in the 1970s and afterward, because of the birth of the "personal computer". First, a small electronic kit maker in Albuquerque (MITS) designed the Altair 8800, and offered it to the public for $395. Later, the Apple II was introduced at a higher price. However, Apple's outstanding functions in handling spreadsheet and word-processing immediately created a market for its products and other personal computers, which made personal computers' sales skyrocket. By 1977, there were at least 30 firms making personal computers (Freberger and Swaine 1984).

The combination of personal computers and printers not only had all functions possessed by a stand-alone typewriter, but also had other functions typewriters could not perform. This task-unification feature of the personal computer made a stand-alone typewriter redundant. Besides that, personal computers used the standard QWERTY keyboard, which allowed typists to easily shift to the personal computers. Along with the development of the personal computer, typewriters were rapidly replaced in both offices and households. By 1987, personal computers of all manufacturers were outselling word processors by 4.5 times.

Facing a life or death threat, IBM once again demonstrated its braveness in embracing new technology. In August 1981, it introduced the IBM PC and grabbed 30 percent of the market share, which was regarded as a landmark event, because it legitimized the personal computer industry. IBM PC used an open architecture and made its operating system information available to the public. In this way, it became a center of gravity for applications software developers. However, the fact that IBM PC was built largely from nonproprietary components opened the door to many imitators who created "IBM compatible" machines and peripherals. Before long, the vast majority of personal computer users were operating equipment that shared the same operating characteristics as the dominant IBM PC. Owing to the success of IBM, Wang Laboratories went bankrupt in 1992.

A common view within the PC community is that the company failed because it specialized in computers designed specifically for word processing and did not foresee (and was unable to compete against) general-purpose personal computers with word processing software in the 1980s. Olivetti, which bought Underwood in 1959, and Royal in 1986 introduced its first personal computer, the Olivetti M20 in 1982. The company continued to develop personal computers until it sold its PC business in 1997. Brother continued its printer business. The SCM or Smith Corona, once a large U.S. manufacturer of electronic-power typewriters, experienced sales declines in typewriters in the mid-1980s due to the introduction of PC-based word processing and was bankrupt in 1995. Royal stopped its manufacturing of the last model of typewriter—Royal Cavalier—in 1990.

4. Case of the Vending Machine Industries

A holy water dispenser (215 BC--1880). The first vending machine invented by Hero of Alexandria around 215 BC. The machine was designed for one purpose, to dispense holy water. At the time, people were taking too much blessed holy water so this machine helped regulate the amount each person received. A person inserts a coin into the top of a box. The coin hits a lever like a balance beam. On the other end of the beam is a string tied to a plug which stops a bottle of liquid. The tilting beam lifts the plug and dispenses the water until the coin drops from the beam. Although the early device only has one function to dispense holy water, it proves the feasibility for using such a device to distribute something (Maguire, Anand and Xie 2013).

Single goods dispenser (1880-1896). Modern day coin operated vending machines started in England around 1880 before they arrived in the US around 1888. These coin-operated modern day machines first dispensed post cards, which were widely used by every household. In 1888, Thomas Adams Gum Company built the first American vending machine to sell Tutti-Fruitti gum on New York City train platforms. Adams' true genius was the location choices for his vending machines. He placed his first handful of vending machines on the platforms of the New York City subway system. Because there was significant waiting time between subway cars, a self-service machine was perfect. For a penny consumers could get chewing gum for their subway ride. Automatic vending and the convenience of self-service and 24/7 availability of products were unknown to the American public at the time. This changed the relationship between vendors and customers (Maguire, Anand and Xie 2013).

Multiple goods dispenser (1897- end 1930s). In 1897, Pulver Manufacturing Company added small figures in vending machines which stimulated the vending machine industry and spawned the vending machine game industry. The yellow kid figure pivoted towards the gum as it dropped down the shoot. The popularity of the first windup animated vendor led to Pulver's long-lived commercial success. After this game came the pinball machines and other vending type games. In 1907, the round, candy-coated gumball, a staple product in modern vending machines, was introduced. Gumball vending machines are still very popular everywhere in America today. The first cigarette vending machine was invented in 1926 by American inventor William Rowe – it was wildly successful. With the growing population of smokers, the matchbox vending machine was also created. These machines could oftentimes be found together in large cities. A surge of vending machine inventions occurred in the 1930s. During the Depression, Rowe's vending machine was invented which dispensed single cigarettes for a penny. The single cigarette was sold because people could no longer afford to buy a full pack of cigarettes. A lotion dispensing vending machine was also invented during this time. For a penny, you could get a pump of lotion after washing your hands. In 1937, the classic Coke and Pepsi soda machine were introduced and were the first bottled drink vending machines. From this time on, full-line vending machines were able to sell cans or bottles of soft drink and individual packages of snacks. During the period, more players enter the competition, with various types of innovations. Functionality increases, industry domain expands and the new fashion spreads. After the success of the vending machine for single cigarettes, a vending machine that dispensed a box of cigarettes with a matchbook was introduced. This eliminated the need for two vending machines and led the way to the collaboration of vendible products, such as the combination snack and soda vending machines(Maguire, Anand and Xie 2013).

The growth of vending machine and consolidation of vending machine manufacturers and operators (1940s - 1950s). In contrast to **the case of m**any small companies joined the vending machine industry, each creating its own machines, the industry had been experiencing a consolidation. On the one hand, vending machine manufacturers were consolidated and larger equipment manufacturers appeared. For example, Oak Manufacturing opened its doors in 1948. It quickly became one of the largest equipment manufacturers in the industry. In 1949, Roger C. Folz purchased his first vending machine and became the largest operator of bulk vending equipment in the United States, owning and operating over 150,000 machines nationwide, at its peak. Full lines of vending products became available to American factory workers during this period. On the other hand, Coca Cola soda dispensing vending machines dominated the market. However, the Coca-Cola company feared that requiring multiple coins (e.g. six pennies or one nickel and one penny for six-cent Coke) would reduce sales and cost money to implement, among other things, they were forced to keep the price of Coca-Cola at five cents. Over the two decades, innovation of the vending machine industry had been focusing on vending machine locks/security, accounting and settlement of the finances. At the end of this period the effect of rising commodity prices and decline in metal heavy industries helped end the golden age of vending. For example, the successful Pulver Company, which helped diversify vending in the 1900s, went out of business in 1954 and all their materials and ingredients were sold at public auction. This marked the low period of vending (Maguire, Anand and Xie 2013).

Teller-Like vending machine (1960s). As the classic vending machines such as Coke and Pepsi soda machines were not able to make change for customers. Therefore, customers needed to have the exact change to purchase a soda. This created an inconvenience for the customers and consumption. Innovation in this period helped solve this problem. After the dollar bill acceptor was invented in the 1960s by John Greenwick, a former Mars Electronics employee, electromechanical vending machines started to appear in the late 1960s. This innovation enabled vending machines to sell multiple products at various prices, which made vending machines tiny retailors: more goods could be sold at varied prices (Maguire, Anand and Xie 2013).

Stagnancy of the vending machine industry (1970s-1980s). Continual inflation during this period changed the perceptions of value. Consumers started to demand a fair price for perceived value of products. The price increase of gas products during this time forced distributors to rethink transportation costs. The reduced customer purchasing power forced vending machine owners to pay more attention to management controls and competition. Surviving pressure resulted in broadening the array of products sold to customers through vending machines. For example, a large variety of useless toys were sold in 1980s vending machines such as stickers, rubber figures, magnets and the like (80s vending machine toys). Coffee making vending machines which ground their own coffee were introduced in the 1980s but cost more than other coffee distribution methods (Segrave, Kerry).

It is said that nothing else too exciting happened in the 1980s in the vending machine industry (Maguire, Anand and Xie 2013).

Dichotomy (1990s-Present). Since 1990s, the vending machines were engulfed in a broadening self-service movement when traditional vending machine operators were exiting the market. Two sustaining loops could be identified during this period.

Loop 1: burgeoning of automated retail kiosks (1990s-2000s). The wide spread of the internet technology has drastically changed the concept of self-service. As consumers can research products online before purchase, they no longer need as many sales people-they just want to go in the store and purchase the item. In Belgium there is a fully automatic fry vending machine installed at a grocery store. The machine prepares a half-cup portion of fries in 90 seconds for $3.50 — sauce included. Starting in 1994, vending machines successfully approached the basic food commerce specialization and began to compete with the fast-moving consumer goods industry. Farmers are moving into the vending machine industry. Some basic food vending machines are owned by farmers selling their production directly to consumers, providing fresh food to urban population at low prices, small operational costs and encouraging distributors. Also an increasing number of vending machines are being used for purposes other than refreshment dispensing. Redbox's bright red machines deliver DVDs in most grocery stores, electronics and related accessories are available in big, glass front machines. Gold, flowers, cosmetics, library books - they are all being offered from automatic merchandisers. Some vending machines dispensed personal products, typically in public toilet facilities. The machines in ladies' restrooms typically sell pads or tampons. The machines in men's rooms, when they are present, are most commonly for the sale of condoms, though in some locations they may be found dispensing cologne, medicine, small candies, or even pornography. Automated retail kiosks enable consumers to do things like charge their cell phones or purchase a camera while traveling. The idea of self-service is changing radically as customers prefer to help themselves more and more. This trend also reduces labor costs for management (Maguire, Anand and Xie 2013).

Loop 2: burgeoning of smart vending machines (2000s--). Untraditional functions can be performed by a new generation of vending machines after the automated retail kiosks are wide spread. Supported by information and communication technology, some vending machines let you create what you want. The Dreambox is a first-of-its-kind 3D printer (Dreambox). Big companies such as Facebook are reducing costs by using machines to dispense employee supplies. A U.K. Coffee company is offering a free cup of coffee but you must complete a task given to you by "Kenneth" the vending machine, which makes it an Interactive Video Vending Machine--Talking Vending Machine. Vendtxt Vending Inc. is working on a vending machine that will enable customers to purchase products via text message. The user sends a text to a short code and receives a text message back with a four digit numeric code. The user then enters their code into the vending machine and makes a selection. If their product is delivered the mobile phone account is charged. Another important development in the industry is the development of healthcare related vending machine. Changes in school health policies inspired the world's first 100% healthy vending company-- Human Healthy Vending. These machines can be found in 40 states, Canada and Puerto Rico. Vending machines are now used in other parts of the health industry such as in prisons, to help distribute methadone. These help wardens ensure the methadone is going to the right prisoner by using retinal and fingerprint scanners. In Canada, a firm is developing a "remote-pharmacy dispensing" machine with customers speaking to a real-life pharmacist via videophone before scanning their ID to get their medicines. Medbox, the first manufacturer of medical marijuana dispensing machines, is confident that they will dominate the industry in the near future as many states already have started legalizing medicinal marijuana use. The machine costs over $50,000 and shares comparable design with Redbox DVD dispenser, except it is armored and has refrigeration. The 2012 earthquake in Japan has forced some vending machine company owners to take a fresh look at how their machines operate during a crisis. The disaster has spurred more efficient vending machines that keep items cold longer in the event of an outage. Some specialized machines will be able to solicit donations for victims and possibly dispense crisis information, free drinks and food during an emergency. Walmart and Amazon are testing these concepts of a cross between a left-luggage locker and a conventional vending machine. Customers can order products online and have the items delivered to a locker. The customer must pick the items up within a set amount of time. Vending company Jofemar announced the launch of its autonomously powered vending machine which runs on hydrogen. This invention means that vending machines will no longer have to plug into electric sockets and the machines can be located just about anywhere. It is apparent that the smart vending machines still have rooms to grow (Maguire, Anand and Xie 2013).

5. Discussion and Conclusion

The typewriter industry and the vending machine industry present two different scenarios. The former brought about a brand new device with special functionality in the 1860s. It penetrated into every corner of the office and many households in the western world. After existing over a century, the whole typewriter industry was wiped out by personal computers beginning in the 1980s. The latter started around 1880s. After experiencing over a hundred year's up-and-down, the industry is still evolving. The vending industry has gone through many innovation stages, some successful and some unsuccessful. The industry seems to have learned that it must keep adapting in order to keep up with the demands of consumers or be left behind, as in the 50's case of Coca Cola machines that couldn't make change. Today there are so many technological innovations that are being tested by the vending industry it is obvious they will not stagnate any time soon. The industry is well positioned to continue through additional self-sustaining innovation loops which will keep the industry fresh and relevant to consumers. Security once was a big issue for vending operators as the old simple mechanisms were so easy to steal from. People would put coin-like objects in the machines, but over time, there are magnetic coin scanners and digital telemetry helps read dollar bills. Improved security and minimizing employee theft is now one of the principal reasons why many retailers are turning to vending machines. Many retailers thing it is easier to utilize vending machines to reduce costs associated with monitoring human employees (Safety Plus Security). Increased security allows retailers to sell things they would never dare sell over the counter to the public. For example, gold bars are now being sold from vending machines (Laboy, Suzette). Affordable wireless technology and digital telemetry are enabling cashless payments to be authenticated. Research shows that 50% of consumers will not purchase from a vending machine if its "Use exact change only" light is on. Machines that utilize this telemetry technology can transmit sales and inventory data from the vending machine to a restocking truck in the parking lot so the driver knows what needs restocking. Consumers will be able to pay in multiple ways and will not have to carry cash to purchase vending products.

Through examining the development of the two industries by using a trifocal lens, the "chain-loop" innovation model presented earlier seems a useful means for better understanding the dynamics of an industry. First, it suggests that there are seven stages instead of four stages in a full length innovation chain based on the all possible combinations of the three types of innovation. Secondly, it claims that an ideal full-length industry innovation chain should not be a single peak life curve, and multiple peaks do exist. Thirdly, it shows that there is not a perfect or magic dominant design which separates product and process innovation. Within the domain of dominant design, two major types—influential design and granted design—both have the capacity to reshuffle an industry. Finally, the model points out that there are sustaining loops occurring between the last three stages of a full-length innovation chain, which expand industry's life cycle with a certain rhythm.

It is also worth noting that the relationship between functionality and delivery are changing over time. The general trend is that functionality and delivery innovation are linked much closer in late peaks than in the first peak. This can be seen from the smaller time gap between functionality and delivery innovation. Corresponding to it, delivery innovation gradually shifts its focus from simply delivering functionality to altering or creating new functionality through the decoding of practices. Taking this feature into account, it is easy to understand why there is no clear linkage between shakeouts and innovation shifts from product to process within the late stages of industrial development.

It is apparent that the combination of the full-length seven-stage innovation chain and the shorter sustaining loop(s) determines the uniqueness of an industry as the cases of typewriter and vending machine industries. However, the configuration of "chain-loop" exists in all cases. It needs more work to revealing the linkage between the "chain" and "loops". So that more practical guidance can be offered in managing the vigorous of innovation, at both industry level and enterprise level.

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