The Parallel Innovation of Musical Instruments

——The Development History of Emotionally Engaging Products in Japan——

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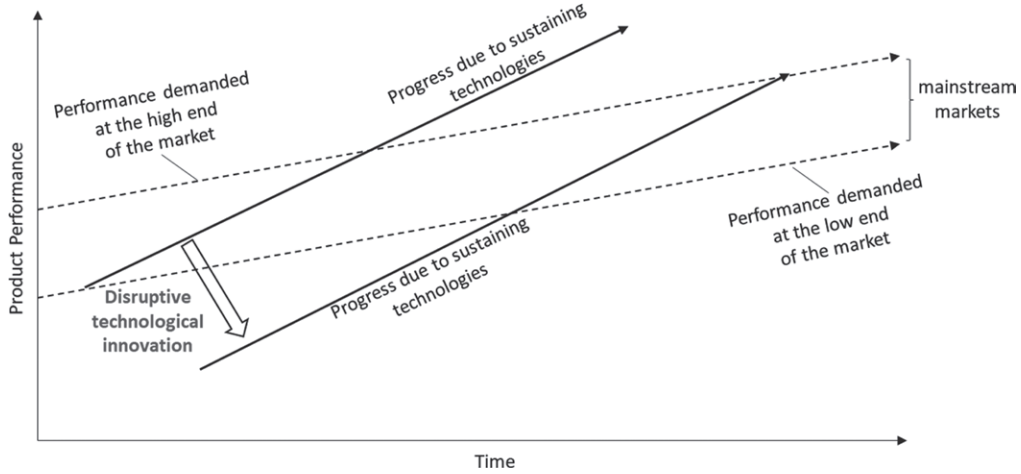
1. The innovator's dilemma in the musical instrument industry

It is difficult to measure the performance of a musical instrument. There are no standards for good sound. A higher price does not guarantee a higher performance. Good sound relies on the human senses, so the reputations of brands and prominent musicians are a secondary factor. In such products, innovation leads to complicated technological changes.

It is well known that the idea of innovation started from Joseph Alois Schumpeter's theory of 'neue Kombination.' It has since been expounded through the various corporate strategies of academic researchers and businessmen such as Clayton M. Christensen who is renowned in the field of product strategy. He explains the innovator's dilemma, and the relationship between sustaining technologies and disruptive technologies (Christensen, 1997). He insists that the sound decisions made by management cause leading companies to fail. When the market is small, and the technologies are still undeveloped, the value of disruptive technologies is uncertain. In such cases, management in leading companies tend not to adopt disruptive technologies. Disruptive technologies do not satisfy a consumers' need in the early stage as the performance of such technologies does not meet even their minimum need (see Figure 1). Mainstream customers choose established products and want companies to continue the sustainable innovation (progress due to sustaining technologies) of existing products. Companies (especially top companies) rationally move toward sustainable innovation, because they base their strategy on value networks, financial structures and the culture of corporate structure: Management make the right decision and do not choose disruptive technologies. Newcomers, however, adopt disruptive technologies as they do not have the management resources of leading companies, and products based on the technologies are typically cheaper and simpler.

Eventually, newcomers continue to make progress by moving to sustaining technologies based on the disruptive innovation. By the time the performance of newcomers, based on sustaining technologies, reaches the low end of the mainstream markets, leading

Figure 1 The innovation's direnma of Christensen



Source: Christensen, 1997, p. introduction xx.

companies' products have already gone beyond the high end of the market. "Historically, performance oversupply opens the door for simpler, less expensive, and more convenient — and almost always disruptive — technologies to enter" (Christensen, 1997, p. 213). Christensen called this phenomenon the innovator's dilemma through his research of the hard disk drive industry, etc.

The theory of the innovator's dilemma has affected Japanese businesspeople since the 2000s, following the emergence of the phenomenon in many Japanese industries after the 1990s. Christensen expanded his theory to the musical instrument industry. He believes that Yamaha (Yamaha Corporation; former Nippongakki Seizo) fundamentally destroyed the musical instrument market, which western makers established, as the company developed disruptive innovations around 1970s-1980s (Christensen, 2001, pp. IX-X). Some Japanese musical instrument companies refer to his theory in their management strategies.

However, Christensen considered the musical instrument industry different from the hard disk drive industry since it is difficult to measure the performance of musical instruments with clear benchmarks, and because disruptive innovation does not drive out traditional technologies. This tendency is also seen in products that appeal to people's instincts, for instance ceramic wares, luxury bags and furniture. In such products, old and new technologies can be sustained in the market, and these technologies form two parallel lines (see Figure 1). This paper will consider this phenomenon from the point of view of the Japanese musical instrument industry.

This paper explores the cases of Yamaha and Casio (Casio Computer Co., Ltd.). Casio

caused innovation to attack other industries by producing a reasonably priced keyboard in the *Casiotone*. Kiyoshi Niwa mentioned this behaviour pattern as becoming an innovator, "If you aim to attack other industries, you should try to destroy and change the base of orbit around its custom" (Niwa, 2010, pp. 11–12). This area of the musical instrument industry will be discussed in Section 2.

Schumpeter Tamada divides innovation into two patterns: "new market type destruction" and "low end type destruction" (Tamada, 2015, pp. 54–55). The latter case is discussed in the history of Yamaha and Casio in Section 2, the former will be looked at the case of Korg in Section 3. "Innovation is a new thing which has economic value", and "these two factors are important, the economic value and the new" (Shimizu, 2019, p. 36). Section 3 indicates that innovation is created through the use of old i. e. analog technology. Innovation in the music industry is demonstrably different from innovation in other industries.

This paper begins with the history of musical instrument technology from postwar Japan. The limitations of the penetration rate of musical instruments become a significant topic.

2. Casio's disruptive innovation to Yamaha: The birth of the new electronic keyboard *Casiotone*

Music education in Japanese elementary schools started after Word War Ⅱ. Before that, most students had not played any musical instruments. Music education took the form of *"Shouka"* education (singing classes). Education in musical instruments was epoch-making in providing music education for every student in Japan, regardless of social class.

The Courses of Study (government guidelines for teaching) in 1961 demanded all elementary school students to play a simple melody on the organ (reed organ). As a result, there was an increase in demand for keyboards in the school market. After the introduction of keyboard classes at school, some parents wanted their children to learn how to play it out of school to improve their grades. Consequently, the private piano market started expanding at the same time.

This movement was accelerated by the image of the *Yamanote area* and the *Micchi boom*. The *Yamanote area* is located inside of Japan Railway's *Yamanote* line loop in Tokyo. It had the image of a high-class residential area, although there were also an old town atmosphere as well as a lot of office buildings and commercial facilities. People pic-

tured piano music emanating from houses in *Yamanote*'s luxury residential areas. Pianos were connected to the notion of wealth. The *Micchi boom* was influenced by the former Empress of Japan, Empress Michiko. Although she was a civilian, she married Prince Akihito in 1959. Many people celebrated their marriage, and the number of women longing to be like the Empress increased rapidly. She became a fashion leader; certain dresses and high heels were made popular by her. Moreover, she liked to play the piano. Mothers wanted to buy a piano for their daughters, believing they would become a beautiful lady like Michiko (Tanaka, 2011, pp. 55–57).

In this way, the piano became a symbol of wealth and a wonderful life. This trend could be seen throughout the prewar period, but it was not until the 1950s that it became a feasible dream for common people. The price of a piano before 1950s was equivalent to buying a house. Japan was experiencing a period of high economic growth with an average annual growth of over 10% from 1954 to 1973. The price of a regular piano (Yamaha basic upright piano U1A: 195,000 yen) was about 9 times the average monthly income (21,324 yen) in 1957. The piano was still expensive, although mass producers (Yamaha and Kawai) pushed down the relative prices of the piano through advancements in their factories throughout the 1950s and 1960s.

Music education issues surrounding the piano remained. Differing from home appliances that can be used immediately after purchase, musical instruments such as pianos could not immediately be put to their optimum use after purchase. Elementary school teachers taught their students haw to play the organ, but they did not teach how to play the piano in earnest. Piano education was still a high-class service, which was provided by well-paid, individual piano teachers. The solution to this problem was a service supplied by *Yamaha Music School*. It offered consumers cheap group lessons. Group lessons are not conducive for learning the piano, because playing multiple pianos at the same time leads to a decaying of sound quality. The piano was an instrument suitable for private lessons. Yamaha resolved the problem by using the organ in group lessons which created a more sustaining sound. Multiple organs played in a group create a more beautiful, harmonious sound.

However, most consumers wanted to learn the piano, not the organ. Yamaha understood that and subsequently named their textbook "Everyone's Organ and Piano Book". Yamaha believed that practicing instruments at home with either a piano or organ would do. It also benefitted the consumer to be able to practice with an organ as it was a cheaper instrument than the piano. Musical instrument stores managed by *Yamaha Music*

Figure 2　Yamaha Music School from 1954 to 1980

year	Student number	School number	year	Student number	School number
1954	150	1	1968	260,000	5,800
1955	500	5	1969	270,000	6,000
1956	1,000	10	1970	300,000	6,200
1957	2,000	20	1971	330,000	6,400
1958	3,000	150	1972	350,000	6,500
1959	20,000	700	1973	380,000	6,700
1960	60,000	1,500	1974	410,000	6,900
1961	120,000	3,500	1975	460,000	7,000
1962	150,000	4,500	1976	500,000	7,200
1963	200,000	4,900	1977	540,000	7,400
1964	210,000	4,900	1978	570,000	7,500
1965	220,000	4,900	1979	620,000	7,600
1966	230,000	5,200	1980	650,000	8,200
1967	250,000	5,500			

Source: "*Nichigaku Syahou*," Nippongakki Seizo Co., Ltd., no.208 (June, 1967); "*Nichigaku Syahou*," Nippongakki Seizo Co., Ltd., no. 220 (June, 1968); 'Changes in the Number of Students at Yamaha Music School,' The Public Reations of YAMAHA Music Foundation, 2009.

School created opportunities to sell their keyboards to consumers (parents) who brought their children to attend music lessons every week. The schools started in 1954 in the basement floors of directly managed stores (*Yamaha Ginza* shop), and it soon became popular (see Figure 2). Yamaha used their dealers to expand *Yamaha Music School* nationwide which cost a lot of money to start up as schools were equipped with expensive equipment (e. g. pianos, stereos and organs). The dealers managed their schools directly and paid a license fee to Yamaha. *Yamaha Music School* is a kind of service brand that does not indicate a specific educational institution. The number of students increased rapidly due to the reasonable lesson fees and good curriculum.

Initially, *Yamaha Music School* used organs, but gradually began to use the new electronic organ. It was called *Electone*. Yamaha began making full-scale electronic musical instruments starting with the *Electone* (D-1) in 1959. Consumers were introduced to it as well as the piano in the music schools. The replacement demand for the *Electone* was expected to be similar to that of home appliances. It had many electronic parts with room for evolution. Yamaha knew that the piano had a limited penetration rate. Pianos are highly durable goods and for that reason, the penetration rate was thought historically low (about 25%) which is equivalent to one in four households. *Electone* had a similar

Figure 3 Casiotone

This is my shot image at Casio Headquarters Exhibition Room (December 2019).

penetration rate and the company placed their hopes on its replacement demand when the demand for pianos declined. This movement was also seen in the musical instrument industry in the United States[1)] .

As expected, Japanese piano demand peaked in 1979 (sales of 310,385 units) and has generally declined since then[2)] . Yamaha had a trump card in the *Electone*, but the effects of destructive innovation started to spread as a result of the entry of different industries at this time. Casio announced that it would enter the field of musical instruments in 1979. Casio was originally a calculator company, and they caused disruptive innovation in the watch industry through LSI technology. They released their first watch with a fully automatic calendar in 1974. Yamaha feared Casio as it had launched innovative products in other industries but realised the company was making a musical toy, after seeing Casio's patent for an electronic musical instrument in the late 1970s. Casio launched its new musical keyboard '*Casiotone*' (see Figure 3) in January 1980.

This was a compact keyboard (49 key and 50 key) which came out in various tones

at a cost of 54,800 - 115,000 yen which was cheaper than the *Electone* (basic type was about 180,000 yen). The *Casiotone* quickly became a popular product for young children in *Yamaha Music Schools*. Light users could not take advantage of the full capabilities of the *Electone* which had a much higher level of performance than the *Casiotone*. *Electone* is located on the up side of the performance demanded at the high end (Figure 1). Similarly consumers were unaware of the level of sound quality in the Sony *Walkman* (high-quality sound) and the *Apple iPod* (stylish & moderate sound quality). Children were the main students for music schools in Japan, so Yamaha moved to produce the same kind of product in the *PortaSound* in December 1980. It was a complicated product strategy that led to the cannibalisation of its own products (*Electone*), but Yamaha dealt with it quickly.

Yamaha released cheap keyboards to compete with Casio after 1980 (See Figure 4). How was Yamaha (the leading company in this industry) able to deal with the disruptive innovation in its industry? The answer was in the low penetration rate of pianos and *Electone*s. Yamaha was apprehensive about its penetration rate during periods of high economic growth. Genichi Kawakami (CEO of Yamaha) was known as the theorist of the declining musical instrument industry. When talking about the future of the instrument industry in 1958 he said, "Even with such excitement, there is a limit as to how much musical instruments could spread among the music lovers".[3] He forcefully modernised and rationalised production, and focused on popularising music through the opening of music schools and the promotion of music events (the Yamaha Popular Song Contest) to increase consumers (Hiyama, 1964, p. 97). He also furthered business diversification in preparation for the drop in demand for musical instruments. Yamaha has a variety of businesses such as the production of furniture, kitchens, ski plates, tennis rackets, baths, motorcycles (independent as Yamaha Motor Co., Ltd.), and managing resort facilities. *The Japan Economist* described Yamaha as changing from "piano makers" to "general wood makers" and "leisure development makers."[4]

Yamaha had always been troubled by the penetration rate of musical instruments. This was the driving force for solving the problem of disruptive innovation and the innovation's dilemma.

Figure 4 The comparison of the musical keyboad

Year/Month	Electrical Keyboad Yamaha	Price	Casio	Price	Entry model of Pianos and Organ Yamaha	Price
1980 Jan.			Casiotone CT-201 (49 Keys)	¥97,000		
July			Casiotone CT-101 (50 Keys)	¥54,800		
Sept.					UP Piano U1M (88 Keys)	¥410,000
Nov.			Casiotone CT-301 (49 Keys)	¥95,000		
			Casiotone CT-401 (49 Keys)	¥115,000		
Dec.	PortaSound PS-1 (32 Keys)	¥23,500				
	PortaSound PS-2 (34 Keys)	¥29,500				
	PortaSound PS-3 (44 Keys)	¥36,000				
1985 Feb.			VL-1 (29 Keys)	¥12,800		
Oct.	PORTATONE PS-10 (44 Keys)	¥75,000				
	PORTATONE PS-20 (49 Keys)	¥95,000				
	PORTATONE PS-30 (49 Keys)	¥115,000				
Nov.			Casiotone CT-701 (61 Keys)	¥148,000		
1982 Frb.			Casiotone CT-601 (61 Keys)	¥110,000		
Apr.	PortaSoundPC-100 (44 Keys)	¥78,000				
June					Electone B-101	¥175,000
July	PortaSound MP-1 (45 Keys)	¥98,000	Casiotone CT-501 (49 Keys)	¥98,000	(Upper 37 Keys, Middle 37	
Oct.	PortaSound PS-300 (47 Keys)	¥37,000			Keys, Food 13 Keys)	
	PortaSound PS-400 (44 Keys)	¥46,000				
Dec.					UP Piano U1A (88 Key)	¥450,000
1983 Jan.			Casiotone CT-7000 (61 Keys)	¥155,000		
1984 Feb.	PortaSound PS-200 (37 Keys)	¥24,800	PT-80 (32 Keys)	¥16,300		
Mar.					Electone FC-10	¥195,000
					(Upper 37 Keys, Middle 37	
1985 June			Casiotone CT-101 (49 Keys)	¥32,300	Keys, Food 13 Keys)	

Source: "*Nichigaku Syahou*," Nippongakki Seizo Co., Ltd., no. 384 (December, 1982) ; Japan Music Trades, 1999 and 2002; Homepages of each company.

3. Innovation to step back: KORGs development of the analog musical instrument from digital technology[5)]

When Casio created a low-price musical keyboard, Yamaha produced a similar innovation in the field of the synthesizer through digital technology in the 1980s.

The history of the synthesizer started with the RCA electronic music synthesizer (known as *Mark* Ⅱ) in 1955 (Koizumi & Iwasaki, 2011, p. 193). The synthesizer was a new musical instrument born after the Second World War. Before that, there were many electronic instruments that had been developed in the West, for example the *Telharmonium* (in 1895; electronic organ), *Theremin* (in 1919; no touch instrument), *Ondes Martenot* (in 1928; electronic keyboard), *Trautonium* (in 1928; electronic keyboard) and the *Hammond Organ* (in 1929; electronic organ). Users could not create a completely new sound but could layer tone and sound together. They were different instruments from the synthesizer. However, the *Mark II* was a huge device using a vacuum tube, and punch cards were used for input. It didn't look like a musical instrument. Synthesizers with a keyboard as the input device had become popular due to the success of Robert Moog. Moog produced small sized synthesizers, the *Moog* Ⅲ with white and black keys in 1968. It was able to reduce the size by using transistor parts[6)] .

Korg (former Keio Giken Industries) was the first to announce the synthesizer in Japan. They released the prototype synthesizer to the public at the *All Japan Audio Fair* in 1970, and put the *KORGUE* on sale on the market after improving the prototype in 1972. The *KORGUE* was released as an electronic organ, but it could also have been released as a synthesizer as it came with a device that could freely change the tone. The catalogue for the *KORGUE* was labeled "Professional Electronic Organ with Traveler Synthesizer". The *Traveler* was the original mechanism that could seamlessly change the sound by moving a lever left and right. *KORGUE* was a technologically epoch-making product, but it failed commercially because it was expensive (430,000 yen) and there were many competing products (Yamaha, Kawai, Victor and Matsushita etc. all made a similar product).

Korg produced a small synthesizer, the *miniKORG 700* after the *KORGUE* in 1973. The concept of the *miniKORG 700* was to sell it as an optional device for the *Electone*. It was developed as a third keyboard that upgraded the *Electone* to a two-stage keyboard. This idea had already had some success with the rhythm machine (*MINI POPS*) which was installed as an auxiliary equipment for the *Electone*. The *miniKORG 700* was a fail-

ure, but few consumers played a third keyboard instrument, and furthermore they had a high affinity with *Electone*. The *miniKORG 700* was rather successful in the United States, which sold as a stand-alone synthesizer and a reasonable replacement for the *Minimoog* ($1,495). The *miniKORG 700* was improved for the American market, adding a ring modulator and twin oscillators. This export model was called the *miniKORG K-1* ($499) in the United States and the *miniKORG 700S* otherwise. They were popular world over and confirmed Korg's reputation as a synthesizer maker.

Korg released various synthesizers in the 1970s. The *MS-20* (released in 1978), was inexpensive, enabled full-scale sound to create and could process all external audio signals, became a hit product with a cumulative sale of 22,000 units. However, equipped with all the functions (polyphonic, memory function and preset sounds) required of synthesizers at that time, *Polysix* became a bestseller with sales of over 26,000 units. Korg released a series of worldwide hit products. Korg's products pitch was stable and adopted a Hz/Volt system different from the Moog's (Oct/Volt), but these were analog synthesizers. They were unlike digital synthesizers, which could achieve a stable pitch over a long time.

The first successful digital synthesizer was the *Synclavier* of New England Digital Co. in 1977 which adopted an FM sound source (digital sound). Its was priced at over $100,000 and it was limited to corporate purchases such as studios. Yamaha had the technical patent for FM synthesis since 1977, but was unable to release products that would be accepted by the market. Yamaha saw the success of *Synclavier* and started developing a synthesizer with an FM sound source. Then, Yamaha released the *DX7* within a price range suitable for personal use (about $1,240). The *DX7*, coupled with its near future body design, sold 180,000 units worldwide. This was the disruptive innovation in the field of the synthesizer.

Korg started to develop a full digital synthesizer as they did not have one. A digital synthesizer can express more tones than an analog equivalent, and the synthesizer trend was shifting to digital. The *POLY-61* (in 1982) and *POLY-800* (in 1983) went on the market. Their selling point was in adopting the digital access control method and displaying numerically, each parameter, but they were only partly digitised (using a digital oscillator and analog filter), and it was operated with an analog synthesizer with a digital screen. The *DW-6000* was also a partly digital machine with an analog noise simulator. The Korg's synthesizer in this era was a product in transition from analog to digital.

A custom IC was required in order to make a completely digital synthesizer, and its development required a long time and huge IC development costs. The development peri-

Figure 5　The production and sales of synthesizer in Japan

year	production	total sales		shipment	
	unit	unit	amount (1,000 yen)	export	domestic
1988	294,014	248,000	18,125,000	195,928	52,072
1989	272,303	273,410	21,961,000	218,976	54,434
1990	313,132	258,956	25,788,000	209,105	49,851
1991	217,508	220,163	21,513,000	175,196	44,967
1992	209,229	214,875	19,576,000	181,227	33,648
1993	118,320	125,282	12,073,000	93,897	31,385
1994	142,771	136,829	11,067,000	102,186	34,643
1995	141,535	143,577	10,929,000	103,284	40,293
1996	140,354	146,840	10,281,000	111,306	35,534
1997	143,808	146,041	10,416,000	118,001	28,040
1998	121,623	128,122	10,071,000	105,046	23,076
1999	114,092	118,655	884,000	98,140	20,515
2000	110,768	113,066	9,013,000	98,671	14,395

Source: Research and Statistics Department of the Minister's Secretariat of the Ministry of International Trade and Industry (1989–2001) "Yearbook of General Merchandise Statistics" (Japan: Tokyo)

od for one model was about 8 months at the longest in the analog era, but it took several years to develop when it came to the digital era. Only manufacturers that could generate big enough sales commensurate with the long development period could develop digital synthesizers. The digital synthesizer was an innovation that only a large company could afford. The Yamaha *DX7* was proof of the company's high ability to develop products and capital strength. There were a lot of synthesizer makers in the world, companies without adequate financial resources left the industry due to the effects of digitalisation.

Korg responded to this crisis by forming a capital alliance with Yamaha in 1985. From the previous year, Korg began thinking about the concept of a next-generation full digital synthesizer which was called the *M1*. It used a 16-bit sampling sound source (PCM sound source) and combined independent equipments (sequencer, effector and rhythm machine) in one. The *M1* was released in 1988 for 248,000 yen. It quickly became a popular model, reaching 100,000 units in two years after its release, and a total of 160,000 units were sold in the world. The *M1* was a historic model with a highly expressive PCM sound source that ended the DX7 era. That time was the peak of synthesizer manufacturing and sales in Japan (See Figure 5).

One machine after another Korg applied their digital technology to new synthesizers,

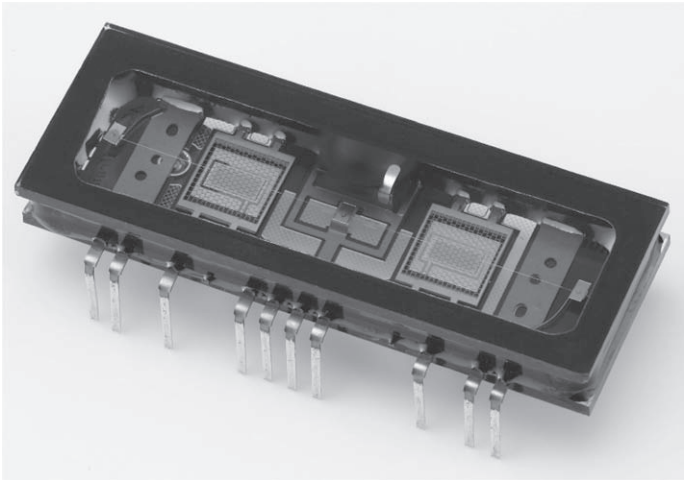
(for example the *WAVESTATION* in 1990, *0/1W* in 1991), other musical instruments and electronic products. The electronic piano was a typical example of a musical instrument using digital technology. The first electronic piano in Japan was Roland's *EP-10* in 1974. It was Yamaha's *Clavinova* with an FM sound source that accelerated the spread of electronic pianos in the market. Korg started to turn out digital pianos (the *DP-80*, *DP-2000C*, *DP3000C*) from 1986. Korg is now one of the world's leading electronic piano manufacturers, along with Yamaha, Roland and Casio. The Korg digital technology also created *karaoke*. The *Hi-Kara*, released in 1989, was the pioneer of compact electronic *karaoke*. Korg had also entered the field of commercial *karaoke* through its business alliance with Clarion.

They were also involved in the development of mobile phones. In the late 1990s, NEC asked Korg to help develop more inexpensive software sound sources than the custom IC. Korg developed the new sound source chip using the DSP (Digital Signal Processor) algorithm and succeeded in producing sound like a custom IC by emulating the FM sound source. The new sound source was installed in Sony's mobile phones. Korg was drawing attention to the DSP as an alternative to custom ICs since the 1980s, and it has been used in various products in the evolution of their digital technology.

In the 2000s, analog musical instruments became the focus of attention in the music market; there was a re-evaluation of old technology in electronic musical instruments. Korg used the DSP to arrange the analog synthesizer *MS-20* in a modern style and released it under the name *MS2000*. Similarly, musical instrument manufacturers have tried to reproduce analog musical instruments using digital technology. From the beginning, the aim of the electronic piano was always to get closer to analog pianos (acoustic pianos). Digital musical instruments have always been regarded as fake. Korg released a real analog amplifier (the *VOX Valvetronix*) using a vacuum tube in 2001, as opposed to a fake analog amplifier that digitally processed tones using the DSP. *VOX Valvetronix* had gained popularity not only among amateurs but also professionals. The sound fluctuation in analog products could not be expressed digitally (especially soft sounds). Although Korg had been promoting digitalisation since the 1980s, vacuum tubes were also used in electronic pianos such as *SV-1* (2009) and *ELECTRIBE MX* (2003) sequencer. The highest performing electronic musical instruments have utilised analog technology.

Supply of vacuum tubes had been a problem since the 2000s. The majority of purchases came from China, Russia and Eastern Europe: Japanese manufacturers rarely produced vacuum tubes. There were however, many defective vacuum tubes coming from

Figure 6　Nutube



Source: TANAKA, 2018, p. 321.

China and Russia. Korg demanded high quality and stable vacuum tubes. They created a new vacuum tube (the *Nutube*) using a fluorescent display in collaboration with Noritake Itron Corp in 2016 (see Figure 6). The *Nutube* operated at less than 2% of the electric power of orthodox vacuum tubes, size was reduced to less than 30% , and continuous use time was 30,000 hours. It was the highest performing vacuum tube ever.

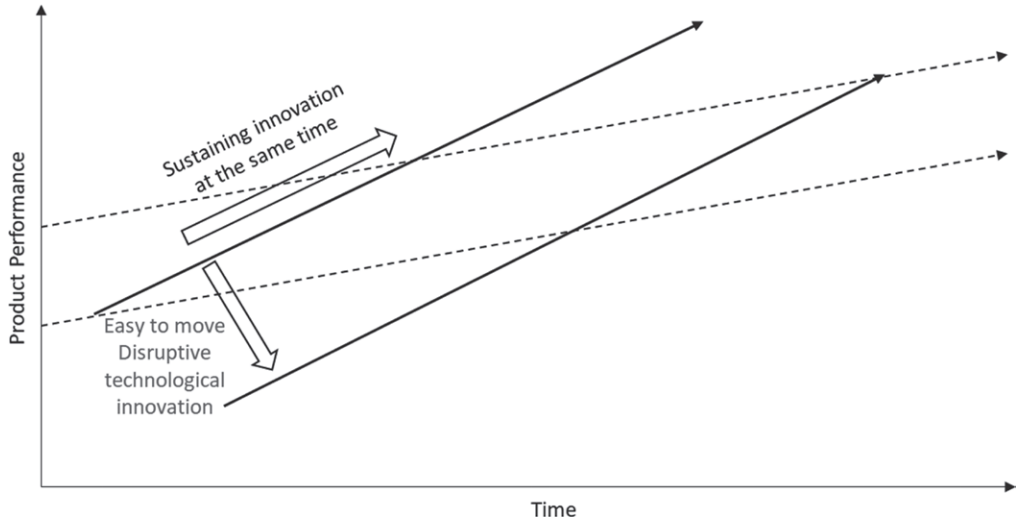
In this way, the performance required at the high end was born by low technology. The evolution of musical instruments was not only from analog to digital, but also the other way round.

4. Parallel innovation: The highest performance appears in low technology

When the 250MB hard disk evolved to 500MB through the application of new technology, the 250MB hard disk declined and disappeared from the market. Many innovation theories insist that old technologies and ideas can be replaced by new ones. A different story appears in the musical instrument industry.

As mentioned in the second section, when disruptive innovation occurs, some existing companies (such as Yamaha, the industry's leading company) adopt disruptive innovation without hesitation. At the same time, sustaining innovation of existing products is maintained at these companies. The *Electone* was being pushed out of the market especially for beginners by the *Casiotone*. However, the *Electone* was closely connected to *Yamaha*

Figure 7 The innovation of emotionally engaging products

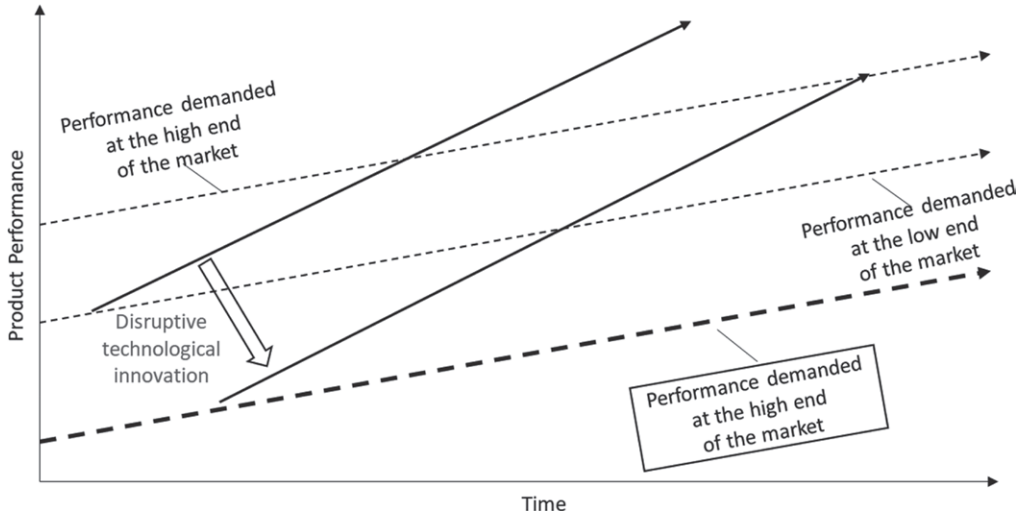


See also Figure 1.
Reference: Christensen, 1997, p. introduction xx.

Music School where the level of students varied from beginners to advanced learners, therefore Yamaha had to persevere with sustaining innovation for as long as the distributors continued to manage the music schools. On the other hand, due to the low penetration rate of the *Electone* and the piano, Yamaha was forced to adopt disruptive innovations to attract consumers. The existence of *Yamaha Music School* led the company to adopt two-way innovation (See Figure 7).

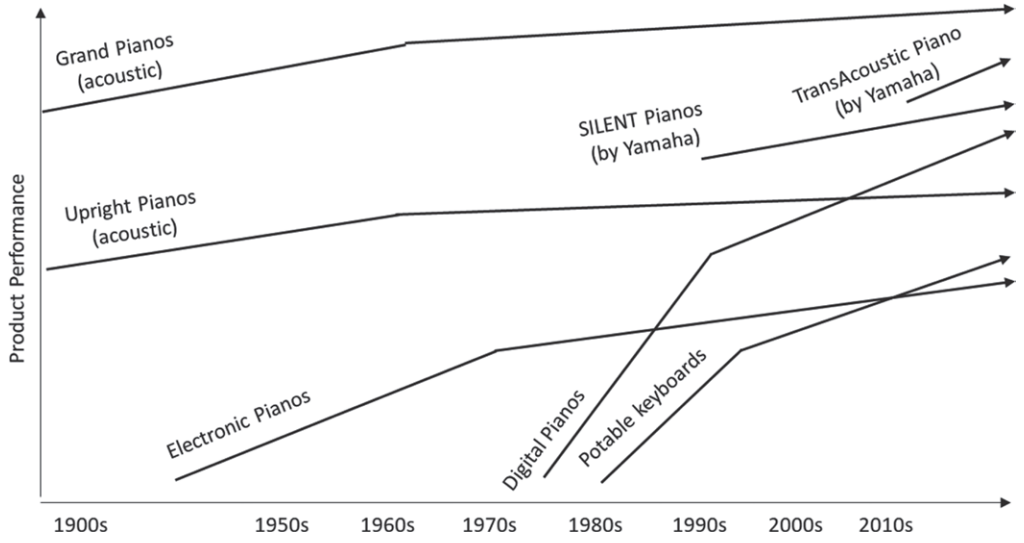
The discussion in the third section clarified the recession of innovation in the field of instruments. Figure 8 shows a new demand line (the bold dotted line at the bottom). The new line of "Performance demanded at the high end of the market" appears under the low end line, because the latest digital technology could not drive out analog technology as is outlined in the third section. As is the character of musical instruments, when new technology emerges, old technology is gradually reassessed. The sound sources used in the latest electronic musical instruments are sampling and modelling sound sources. Digital sampling sound sources are created by using the good part of the digitally simulated sound waveform which is recorded in raw sound. This method was attempted with an analog musical instrument called the *Mellotron* in the 1960s. The *Mellotron* uses a tape playback system and when we press a key, we hear the recorded sound. *Mellotron*'s technology is far inferior to digital sampling, but it was re-used by professional musicians in the 2010s. The highest performance suddenly emerged below the lowest performance re-

Figure 8　The new demand line appears



See also Figure 1.
Reference: Christensen, 1997, p. introduction xx.

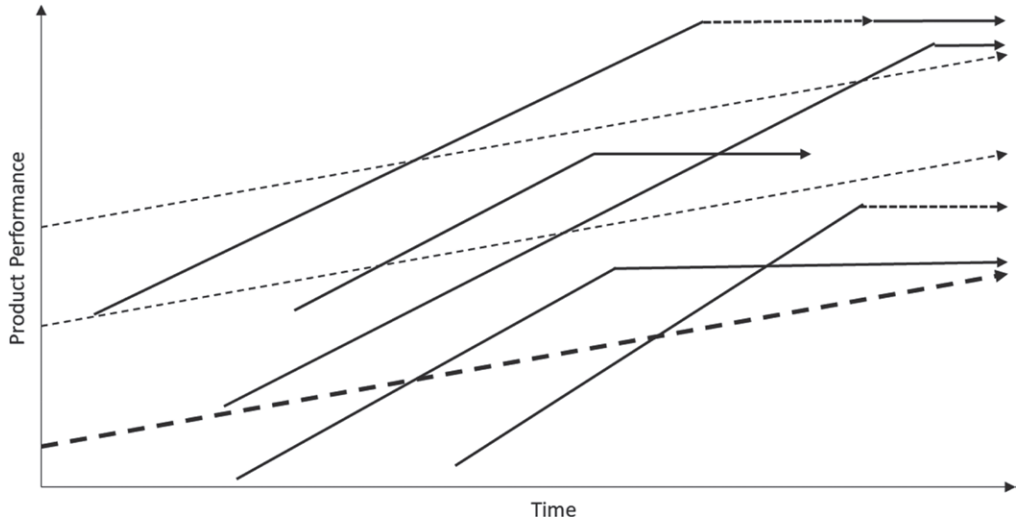
Figure 9　Various types of the piano（conceptual diagram）



quired by the market. Such cases are often found in the world of music where a products' originality is pursued.

Various types of the piano have emerged throughout its history（See Figure 9）. It is assumed that there are heated discussions about the technology and playability of each piano, but I created a conceptual diagram in Figure 9 in order to consider the existence of innovation[7)] . It should be noted that old technology will not disappear. Digital pianos, for

Figure 10 The parallel innovation of musical instrument



See also Figure 1 and 8.
Reference: Christensen, 1997, p. introduction xx.

example, have developed with excellent digital sound sources since the late 1990s, but they still imitate the tone colour and the touch response of acoustic pianos. The key touch of grand pianos became heavier because pianists sought sufficient volume and power to play at large halls in the 19th century. Digital pianos, which can easily increase the volume, do not need to have a heavy touch. Essentially, to a certain degree the digital pianos' light touch improves playability and allows pianists to express themselves in a different way from traditional acoustic ones. Around 1990, Meiko Miyazawa, a famous pianist in Japan, gave lectures to piano teachers nationwide about the new possibilities of the digital piano at the request of Korg (TANAKA, 2018, pp. 279–280 etc.). As this was too progressive, it was not accepted by many Japanese pianists who had studied classical music. Musical instruments are always drawn to former innovations, so the old technology does not easily disappear.

It does not mean that musical instruments are thrown into a dustbin just because its technology is either new or old. The innovation of instruments stops evolving when it reaches a certain level in players' demand. In other industries, when innovation stops, products tend to disappear from mainstream markets. However, most musical instruments continue to exist in parallel as shown in Figure 10. On the other hand, some musical instruments disappear from the mainstream markets, while some are resurrected. Basically, musical instruments accumulate a lot of technological standards. Although further

evidence is required, it is thought that emotionally engaging products, not limited to musical instruments, have the same tendency.

There are various types of musical instruments and many accessories. Moreover, since old and new technologies exist in parallel, the existence of a wholesaler is necessary in the musical instrument industry. Even with leading musical instrument manufacturers such as Yamaha, it is difficult for one manufacturer to manage all products. The musical instrument stores that conduct business with only one manufacturer will find it difficult to survive even if they increase their expertise. The musical instrument industry is an industry in which distribution is difficult to control. Musical instrument manufacturers require a high level of skill to bring together product innovation and distribution management.

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Notes

1) In 1962, a Yamaha's resident officer in the United States saw the increase of electronic organ sales covering the decline in piano sales. 'The correspondence from the United States,' "*Nichigaku Syahou,*" Nippongakki Seizo Co., Ltd., no. 151 (June 1962).

2) Research and Statistics Department of the Minister's Secretariat of the Ministry of International Trade and Industry (1966-2000) "Yearbook of General Merchandise Statistics" (Japan: Tokyo).

3) "*Nichigaku Syahou*", Nippongakki Seizo Co., Ltd., extra edition no. 7 (March 1958).

4) Mainichi Shimbun Publishing (1975) "Nippongakki Seizo", *Economist,* no. 2079 (April), pp. 98-99.

5) This paper refers to Tanaka (2018) about the Korg history.

6) Don Buchla announced the synthesizer (*Buchla*) with the board which reacts by touching with a finger (no black and white keyboard). Koizumi & Iwasaki, 2011, pp. 193-201; Shirasuna, Tachibana & Mieda, 1977, pp. 9-11; Yonemoto, 2008, pp. 116-117; Mieda, 2010, pp. 1-8; Jenkins, 2007, p. 50.

7) Portable keyboards are not exactly pianos. However, in recent years, questionnaires conducted at some musical instrument stores have revealed that they are considered as pianos by consumers in Japan (from the testimony of people in the musical instrument industry).

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