Can Firms Simultaneously Pursue Technology Innovation and Design Innovation?

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Abstract: There are two types of innovation: technology innovation and design innovation. Each type has a positive effect on corporate performance. However, results of our analysis on the appearance, user friendliness, and technological functionality of cellular phones between 2005 and 2010 show that in the years 2005–2007, when TV functionality was introduced in cellular phones, cellular phone manufacturers sacrificed appearance instead of improving functionality. However, this issue was resolved in 2008–2010, and companies succeeded in simultaneously attaining appearance and user friendliness. In other words, it has become clear that companies in the Japanese market first tend to prioritize functionality through technology innovation than appearance (i.e., industrial design), and then later tend to simultaneously pursue both appearance and user friendliness through design innovation.

Keywords: design innovation, product strategy, product development

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1. Introduction

Products with attractive appearances and intuitive user interfaces appeal to many consumers. This phenomenon has not been a major area of study in business management to date.¹ In recent years, however, there have been studies asserting the importance of industrial design (Rubera & Droge, 2013; Utterback et al., 2006; Verganti, 2009).

These studies categorize innovation as technology innovation and design innovation. Technology innovation improves product specifications or adds new functionality, whereas design innovation enhances appearances and user friendliness. It has been indicated that both types of innovation contribute to product competitiveness.

However, many people may have experienced owning products that have attractive specifications but unattractive appearances. In addition, even within design innovation, the nature of appearance and user friendliness is different and there are doubts as to whether companies can pursue both technology innovation and design innovation the same time.

This paper attempts to analyze the simultaneous pursuit of technology innovation and design innovation (appearance and user friendliness) by firms. Based on the awareness of this issue, this study analyzes the cellular phone industry using product data from 2005 to 2010.

The results of this study show that cellular phone manufacturers in the Japanese market sacrificed appearance to improve functionality when they introduced the TV functionality in cellular phones between 2005 and 2007. However, this issue resolved itself in 2008–2010 and manufacturers succeeded in simultaneously

¹ In examining detailed reviews on product development research by Kuwashima and Fujimoto (2013), Kuwashima (2012), and Kuwashima (2013), one can see that most research focuses on technical aspects.
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Attaining appearance and user friendliness. In other words, companies in the Japanese market tend to prioritize improving functionality over appearance (industrial design), later tending to pursue appearance and user friendliness through design innovation.

This paper is structured as follow: In section 2, the elements comprising products, and how these elements correspond to technological innovation and design innovation are reviewed. Subsequently, the core idea of this paper are introduced. In section 3, the results of our analysis using cellular phone’s product data are discussed.

2. Technology Innovation and Design Innovation

Products with intuitive user interfaces and attractive appearances are popular among many consumers. Studies adopting the Lancaster approach or Hedonic approach noted that products comprise bundles of attributes (Lancaster, 1971; Rosen, 1974). However, most existing studies adopting these approaches point out that attributes are technological functions, such as product specifications (Christensen, 1997; Christensen & Bower, 1996).

However, product attributes also include elements of industrial design such as appearance and user friendliness. Many studies in recent years have focused on industrial design (Gemser & Leenders, 2001; Talke, Soren, Jaap, & Lutz, 2009; Utterback et al., 2006; Verganti, 2009). Industrial design comprises of appearance and user friendliness (Dumas & Mintzberg, 1991; Ulrich & Eppinger, 2009; Veryzer, 1995). Appearance has the special ability to produce an impressionistic image, while user friendliness enables users with a particular context to use something efficiently, effectively, and without dissatisfaction (Gemser, Jacobs, & Cate, 2006).

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2 See Takahashi, Shinaku and Ohkawa (2013) for a detailed explanation of the research of Christensen and Bower (1996).
Some studies incorporate industrial design perspectives into innovation, and categorize innovation as technology innovation and design innovation. Technology innovation of course refers to the innovation of technical aspects, while design innovation affects human sensitivity (Rubera & Droge, 2013; Verganti, 2009). Considering the aforementioned argument about product attributes, technology innovation improve a product’s technological functionality, and design innovation improve a product’s appearance and user friendliness. It has been quantitatively demonstrated that both types of innovation have a positive impact on corporate competitiveness through improvements of technological functionality and appearance (Rubera & Droge, 2013; Talke et al., 2009).

When theoretically considering these assumptions, we can expect a positive impact on corporate performance by pursuing these two types of innovation. In fact, Rubera and Droge (2013) show that interaction between technology innovation and design innovation can affect a firm’s performance. However, a question arises: Is it possible for companies to simultaneously pursue both types of innovation? Because companies will likely encounter technological constraints and many other issues in doing so.

Even within design innovation, appearance and user friendliness have different characteristics (Dumas & Mintzberg, 1991; Ulrich & Eppinger, 2009; Veryzer, 1995). Both have the ability to affect human sensitivity in common, though user friendliness is a value recognized after use, and as such is difficult to assess (Gemser et al., 2006; Thompson, Hamilton, & Rust, 2005). Thus, although they are included in the concept of industrial design, they are still different in nature. Therefore, can companies simultaneously pursue both appearance and user friendliness?

To understand this question, let us now quantitatively analyze whether companies in Japanese cellular phone industry were able to simultaneously pursue technology innovation (technological
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3. Can Firms Pursue Technology Innovation and Design Innovation?

This study analyzes the aforementioned issue using cellular phone’s data from 2005 to 2010 as published in *K-tai Watch*.³ Data on cellular phone’s appearance and user friendliness⁴ was gathered from kakaku.com.⁵ Camera megapixel count and TV functionality of each cellular phone were used as measures of technological functionality. The data of each cellular phone’s camera megapixel count was the specification of greatest importance to users,⁶ and TV functionality appeared on the market around 2005.⁷ We can expect new findings by comparing the results of already adopted functionality and new functionality. The data of each cellular phone’s camera megapixel count and the presence or lack of TV functionality was obtained from the websites of each manufacturer, *K-tai White Paper 2005–2011* (Mobile Contents Forum, 2004, 2005, 2006, 2007, 2008, 2009, 2010), and others.

This study also incorporates time perspectives in the analysis. Corporate efforts in product development fluctuate over time (Shenhar, 2001). TV functionality began to see broader diffusion around 2008, with more than 50% of cellular phones having this

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³ The subjects of this study were models sold in April of the years 2005–2010 in the *K-tai Watch* price survey. [http://k-tai.impress.co.jp/](http://k-tai.impress.co.jp/)

⁴ User friendliness is a composite variable of button operation, character conversion, responsiveness, and menus (Cronbach’s $\alpha = 0.873$ in this sample. It is the average of the four variables).


⁷ The V601N models featured analog TV tuners introduced in the market in 2005. In 2006, the one-seg broadcasting tuners was adopted and the diffusion of TV functionality began in earnest (See Appendix 2 of *K-tai White Paper 2008* (Mobile Contents Forum, 2007)).
We can predict changes in corporate efforts before and after the diffusion of this functionality. Accordingly, this paper separates the periods prior to the diffusion of TV functionality (2005–2007) and after diffusion of TV functionality (2008–2010). The number of cellular phone samples used in the analysis was 105 for the period 2005–2007, and 193 for the period 2008–2010, for a total of 298.8

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8 Samples included those models with five or more respondents in kakaku.com product reviews, and with a retail sales price of 5,000 yen or more in April of each year as noted in the K-tai Watch price survey. This improves the reliability of the data, eliminating any disproportionate bias from a small number of respondents or a bias resulting from essentially
This analysis creates cross-tables of appearance and technological functionality (camera megapixel count and TV functionality) and appearance and user friendliness. Camera megapixel count, appearance, and user friendliness were categorized in the form of high and low levels.\(^9\) With regard to TV functionality, data were categorized in the form of yes or no. Table 1 shows the results of the analysis of product data for years 2005–2007 and 2008–2010. In the Japanese market, the correlation coefficients of both appearance and technological functionality are negative in the years of 2005–2007, showing that companies did not simultaneously pursue both.

In particular, the negative relationship between appearance and TV functionality in years 2005–2007 was significant. Table 2 shows these results. Upon examining this table, we can see that most consumers having cellular phones with TV functionality give appearance a low rating. In other words, the results show that in the years 2005–2007, when cellular phones with TV functionality were non competitive products surviving due to a company’s strategy.

\(^9\) With regard to categorizations, camera megapixel count was categorized based on median values. The categorization of high level for appearance was a value of 4.5 or higher, and 4 or higher for user friendliness.
introduced in the Japanese market, companies sacrificed appearance to improve functionality. At the time, TV tuners for cellular phones were large, and thus we can assume that manufacturers sacrificed appearance to make room for the tuners.

However, in 2008–2010 one-seg broadcasting tuners for cellular phones were miniaturized, doing away with any need to sacrifice appearance and solving the issue. This allowed for the release of many models that had both TV functionality and an attractive appearance (Table 3).

These results conform to Abernathy (1978), Abernathy, Clark,

10 The one-seg broadcasting tuner for cellular phones model VA3A5JZ922 sold in 2008 was a smaller model that succeeded in shrinking the size over the first-generation model by about 80% (from IT Media News, “AQUOS Keitai ya Papyrus wo Sasaeru Sharp no Mobile TV Tuner,” March 4, 2008).
11 See Akiike (2013) for an explanation of this study.
and Kantrow (1983), and Abernathy and Clark (1985). They note that maturing technologies bring a reduction in the rate of major product innovations and a focus on incremental innovations. In addition, Abernathy and Clark (1985) asserted that a series of incremental innovations brings an accumulation of technologies within a company and leads to increasing technological versatility. If this idea is applied, it may well posit that the technological constraint of TV functionality at the time was solved by an accumulation of technologies, doing away with the necessity to sacrifice appearance.

Furthermore, results of the analysis for 2008–2010 show that companies had succeeded in simultaneously pursuing appearance and user friendliness, which they could not find in 2005–2007 (Table 4).

We can assume that it is because the necessity of sacrificing appearance for TV functionality disappeared as companies accumulated technology, and that companies were able to simultaneously pursue both appearance and user friendliness.

These results show that companies in the Japanese market tend to prioritize improving functionality through technological innovations over appearance (industrial design), and later pursue both appearance and user friendliness through design innovations.

Table 4. Cross tabulation between appearance and user friendliness from 2008 to 2010

<table>
<thead>
<tr>
<th>Appearance</th>
<th>User friendliness</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>Low</td>
<td>76</td>
<td>21</td>
</tr>
<tr>
<td>High</td>
<td>61</td>
<td>35</td>
</tr>
<tr>
<td>Total</td>
<td>137</td>
<td>56</td>
</tr>
</tbody>
</table>

Note: Pearson’s $r = 0.163$, $\chi^2 = 5.137$, $p = 0.023$

Source: Created by author.
4. Difficulty of Simultaneously Pursuing Technology Innovation and Design Innovation

Existing studies note that technology innovation and design innovation have the positive effect on corporate performance. However, in the Japanese cellular phone market, companies first tend to focus on technology innovation, and later on design innovation as they bring new functionalities to the market. The discovery of this fact makes a large contribution to existing research. Companies are not necessarily able to simultaneously pursue both technology innovation and design innovation.

It is this tendency that makes it difficult to simultaneously pursue appearance and user friendliness. When TV functionality was introduced in the market, the simultaneous attainment of appearance and user friendliness was difficult because companies emphasized functional advancements at the expense of appearances. When existing research discuss design innovation, they often focused on appearance (Rubera & Droge, 2013; Talke et al., 2009). However, appearance and user friendliness differ in nature, and cannot necessarily be simultaneously pursued. Future research will likely require analyses that clearly differentiate between appearance and user friendliness.

Incidentally, in the Japanese market, companies have first focused on technology innovation, and then on design innovation. However, products with both technological innovation and design innovation have a very high chance of success. For example, when Apple’s iPhone was released in the market, its emphasis on appearance and user interface lead to a smashing success. In addition, the Dyson vacuum cleaner had a huge impact on consumers with an appearance that emphasized the image that the suction of Dyson vacuum cleaner does not weaken with time. As seen from the results of this paper, when companies add a new functionality such as a TV
tuner in cellular phones, they tend to sell products with high functionality and neglect the product’s appearance. However, even in these cases, companies can be successful by releasing products that balance both functionality and appearance.

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