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Abstract:

All quality improvement activities are said to contribute to innovation. That is the basis of conventional quality management. However, our research based on a study of 3 Japanese high tech firms shows that successive quality improvement activities can become an obstacle to innovation, especially to radical innovation. Successive quality improvement activities based on serving current customers nurtures a strong quality culture within a company. This culture creates high standards which can make it difficult for a firm to positively respond to radical changes in markets and technologies which initially offer lower quality performance. Of note is that the highly successful quality strategy of moving error prevention activities upstream can have the unanticipated effect of creating a highly risk averse organization. In addition to exploring these themes, we offer up some exploratory views on how Japanese high tech firms might meet these challenges.

Keywords: quality, reliability, radical innovation, incremental innovation, risk, time to market

JEL codes: L15, L20,Q55,O32

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Quality as an Obstacle to Innovation: Too much of a Good Thing?

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A common topic at quality seminars and conventions and in practitioner journal articles on quality is how quality improvement can contribute to innovation (e.g., Harvey, 2007). Trailblazing empirical results includes Noriaki Kano's work in analyzing the significance of Konica' s development of new camera features in the 1970s in which he showed how a firm's effort to understand customers' latent needs could lead to product innovation (Kano, 1987). There has been remarkably little research, however, on how a firm's focus on quality improvement might inhibit innovation. What research has been done on this topic has been conducted by academics outside the quality field (e.g., Sitkin, Sutcliffe and Schroeder, 1994; Brenner and Tushman, 2002). On the face of it, this is rather odd. To understand how quality might support innovation, quality specialists ought to first understand the conditions under which it interferes with innovation. Our discussion aims to do just that as well as suggest possible ways to deal with these obstacles.

We have chosen for added effect to use examples drawn from the recent experiences of Japanese firms and industries. Japanese firms are widely acknowledged to have been leaders in creating the modem approach to quality improvement. As exemplars of best practice, they give our findings added meaning. It is also widely acknowledged that Japanese firms have drawn strong competitive advantage for their high quality performance and reputation. Most notable is the success story represented by the Japanese automobile industry, a very visible adopter and user of modem quality improvement methodologies. Its high quality performance, especially reliability, has provided an enormous competitive boost for the Japanese auto industry.

Successive process improvements (continuous improvement), built on a foundation of repetitive and relatively stable processes, play a major role in determining success in the automotive industry. Technology changes quite slowly. In particular, safety considerations require that technology be fully tested before being implemented. This takes time and favors incremental innovation. Indeed, most of the empirical research purporting to show that quality improvement is consistent with innovation turns out to focus on incremental innovation (Adler, Goldoftas, and Levin, 1999, Naveh and Erez, 2004). We have no reasons to question these findings. Moreover, it makes intuitive sense that quality improvement activities, properly managed, could lead over time to successive incremental innovations which make major contributions to competitive advantage.

But what about industries in which technological and market changes have been rapid and radical/disruptive change has characterized the industry or technology? We will examine three such cases from the Japanese high tech sector. The first is based on a Japanese colleague's study of Japan's loss of the Dynamic Random Access Memory (DRAM) chip industry to Korea; the second is based on one of the author's study of the Japanese network equipment industry and its adoption of the Internet, and the third is based on the both authors' study of a Japanese software firm, a large system integrator. There is another benefit to pursuing these empirical cases. While other scholars have suggested that quality improvement can inhibit innovation, they have been vague on the organizational mechanisms that are involved. Sitkin, Sutcliffe and Schroader(1994) have provided a conceptual analysis using a contingent model. They stress that control and variance reduction have successfully characterized approaches to quality management in slow moving industries with repetitive processes but these approaches are not suited to conditions of high task uncertainty. This is certainly consistent with our theme that the challenge of quality management may be quite different in the high tech sector where radical/disruptive changes is more common and consequently task uncertainty high. Sitkin and associates' analysis, however, operates at a high level of abstraction stressing for example that non-repetitive error is desirable when exploring new solutions in highly uncertain situations in contrast to the traditional role of quality management in suppressing error. Their analysis, however, doesn't tell us anything about the specific mechanisms and practices involved. Nor is there any description of how innovation inhibiting activities are linked to competitive outcomes.

Benner and Tushman (2002) conducted an empirical study of innovation in the paint and photography industries to see the effects on innovation of adoption of process improvement initiative, ISO 9000. They found that the greater the number of ISO certifications, the fewer the number of original patents. They concluded that a focus of firm resources on process improvement activities and variance reduction crowded out exploratory innovations reflected in more original patents. They did not explicate the organizational mechanisms that produce these outcomes in the two industries but instead relied on the broad scholarly literature for their explanations. The crowding out process they claim derives from an organizational culture focused on incremental improvement and refining existing capabilities and routines. Again, there is no systematic analysis of the implications of their findings for competitive outcomes in the two industries studied. We extend their work by analyzing the following cases in terms of the light they shed on the crowding out hypothesis, their explication of still different mechanisms, and their demonstration of the competitive outcomes resulting from an excessive inflexible quality emphasis.

Japanese loss of the DRAM industry

Takashi Yunogami (2006) studied the Japanese loss of the DRAM industry to the Koreans which took place in the 1990s. We draw heavily on his account in the subsequent discussion. Japanese pre-eminence in the DRAM industry was cemented in the 1970's and 80s as it supplanted American leadership. At this time, their DRAM production was heavily geared to its use in mainframe computers. At an early date, they sought to differentiate their products through high reliability and durability. Japanese producers were said to aim for 25 years' durability. This was in keeping with the primary use of DRAM chips for mainframes at the time.

Japanese DRAM producers created a mindset among employees that equated rising competitiveness with improved quality. Past practices set standards used for succeeding generations of DRAM chips. The production of higher quality DRAM chips became the norm for which engineers aimed with strong support and guidance from powerful quality departments. As a result, more specialized equipment, more "masks," more inspection steps and overall more steps in the process flow were required. The net result was added cost and time (Yunogami, 2006:80).

Japan's computer shipments of DRAMs strongly shifted from mainframes to PCs in the late 1980s. This radical change had major consequences for market demands. Korean producers entered the market focused on the PC market without any mainframe legacy practices. Yunogami reports that they designed their DRAM chips with only as much quality as necessary to meet new market demands. They aimed for adequate quality and high yield with reduced costs. Durability requirements for PCs, with reduced life cycles, were much shorter than for mainframes.. Korean producers purchased less expensive standard equipment, often running that equipment longer than Japanese producers. This reduced development costs and time as well as reducing the number of process steps. All these different practices contributed to their competitive success vis á vis the Japanese.

In summary, the Japanese producers built an organizational culture that failed to adapt and innovate in response to the dramatically different market requirements of the new PC era. They had designed into their development process and organizational culture excessive quality which in turn led to higher costs and longer development times. They were making incremental innovations but not adjusting to the dramatic changes in market conditions produced by the rise of PC technology. We can see this case as one mode of the "crowding out" explanation in which a focus on continually improving existing practices absorbs all resources and energy at the expense of a recognition and response to radical technology and market changes. To be sure, there are other explanations for the Japanese loss of the DRAM industry to the Koreans. This includes management’s slowness in making critical investment decisions to match the Koreans but these alternative explanations are not mutually exclusive.

Challenges in the Shift to the Internet Era and the Network Equipment Industry

Our second case builds on the analysis of Robert Cole of the evolution of the network equipment industry with the arrival of the Internet. (Cole, 2006). NTT served as the dominant technology trend setter for Japanese hi tech and viewed from a competitive perspective, was slow to embrace the Internet. Other major national telephone companies such as AT&T were also slow to embrace the Internet (Naughton, 1999:117). The reasons for their initially negative response to the Internet were common among them.

Like other major national carriers, NTT had powerful internal institutional rigidities that slowed their embrace of the Internet. Above all, the digital Internet protocol challenged NTT's massive investment in analog telephone technology (Naughton, 1999:100-107). The internet was based on totally different principles. It was a best effort network based on packet technology. As a best effort network, the network does not provide any guarantees that data is delivered or that a user is given a guaranteed quality of service level or a certain priority. In a best effort network, all users obtain best effort service. TCP/IP, the Internet protocol, drops many messages (packets do not get delivered on first try); its solution for these dropped messages is to resend them. In the language of quality, this is an undesirable rework solution, but one in which the cost of resending is almost zero (cf. http://en.wikipedia.org/wiki/Best effort delivery).

In the early years of the Internet, this best effort network did not match the traditional quality benchmarks of telephony (in the network area these are known as Quality of Service QoS) benchmarks. In particular, it was deficient in providing sufficient bandwidth guarantees as well as in insuring reliability (correctness of data transfer). These weaknesses were huge in the eyes of NTT researchers and executives.

NTT had a powerful reliability culture that stressed progressive elimination of error. With great effort, they had built a highly dependable system. NTT decision makers believed that the only way to get high quality connection was based on a dedicated connection been sender and receiver -something that the Internet protocol, TCP/IP, did not offer. As late as the mid and late 1990s, TCP/IP protocol was not seen as serious technology by many high ranking NTT executives.

The choice for NTT was made even more difficult because they like many national telephone companies were committed to developing an alternative technology for networking services. Moreover, NTT was more committed than most because they believed they were leaders in developing this new technology and thus stood to benefit most. This technology was known as Asynchronous Transfer Mode (ATM) and it evolved from telephony. NTT began research on ATM in the mid 80s. It was a natural extension of the existing public telephone network. So it would not require the destruction of NTT's massive investment in analog technology and infrastructure -as would the Internet. ATM seemed to hold more promise for Quality of Service (QoS) than TCP /IP. By emphasizing the active configuration of QoS parameters, ATM was expected to insure high quality and reliability This, in turn, was important because of its implications for the reliability of real time communications.

Japanese hitech firms were slow to embrace the Internet and to develop network equipment supporting its deployment as was the case among many incumbent firms in the U.S.

Distinctive to the Japanese case, however, the leading electronic firms, as long term suppliers to NTT, were accustomed to following NTT's technology lead. These long term stable relationships, known as "relational contracting" were held up as model helping to explain Japan's success in the 1980s (Dore,1987: 173-192). In the context of rapid change and uncertainty where the leaders make the wrong strategic technology choice, however, these relationships limit options and can be a recipe for failure. In this case, they greatly slowed the deployment of Internet technology by the leading electronic companies, giving Cisco a huge opportunity.

A key factor that made Japan's response different was its weak start up culture in Japan. This inhibited alternative organizational responses to the opportunities offered by the Internet. In the U.S., many large firms like Hewlett Packard and Microsoft were also slow to embrace the Internet but small venture firms arose to lead the way. This option was not available to the Japanese, with many barriers in the 1990s obstructing entrepreneurial start ups.

The delayed response by Japanese electronic firm gave first to market advantages to Cisco in its development of network equipment for the Internet. Cisco was then able to get their products like routers deployed in the marketplace and then exploit the experience curve and make its operating system software, IOS, the standard software platform for Internet networking. This created strong barriers to entry for late arriving Japanese firms (cf. Gawer and Cusumano, 2002:175-178). American firms, like Cisco and Juniper Networks, continue to dominate the Internet network equipment market. A major element triggering this chain of events was NTT's initial hostility to TCP/IP which, to a significant extent, grew out of NTT's strong reliability culture and the dependency of the major electronic firms on NTT’s leadership.

Quality and Innovation in the Systems Integration Market

Our third case involves an examination of shifts in the system integration market as a result of radical technology and market change. The analysis is based on the case study research of a large software firm by the two authors. The firm in question has been traditionally strong in the public sector and grew up in the mainframe era. Quality, specifically reliability, emerged as a key source of competitive advantage and market differentiation for the firm. Relative to the private sector, customers in the public sector are not knowledgeable about IT. Those from engineering fields with strong qualifications in IT are specifically prohibited from holding policy making positions, thereby excluding them from IT decisions. As a consequence, the software firm could tell customers what they needed. This bred over the years a certain arrogance. It did not prepare the firm to dealing with assertive and knowledgeable private sector customers.

The explosive growth in IT applications in the private sector since the mid 1990s created the biggest industry growth opportunities. But the software firm’s sales and market share has not kept pace with the rapidly growing private sector. Private sector customers value reliability but they also value equally and sometimes more, speed and innovation (new and improved functionality). The firm's "no bug" culture, however, breeds risk aversion and slowness in introducing new features and technologies. It can become all consuming, driving out alternatives approaches to winning customers.

The firm uses a modified version of the “waterfall process” for its software development methodology. The waterfall method is a linear process of development developed for mainframes in which the firm insures against failure through fully specifying customer requirements before writing any code. The key to success in this model is accurately specifying customer requirements up front. The use of waterfall methodology makes programmers more productive, technically speaking, since it allows them to make fewer changes downstream, thereby reducing rework. This approach assumes that the main design specifications can be completely laid out in advance and that the firm's system engineers are capable of extracting these "secrets" from customers. This methodology is consistent with the quality principle that quality should be built into design of product and services as early as possible as part of a prevention strategy.

Market needs, however, changed greatly with the arrival of the PC era. In response to rapidly changing markets and technology, customer needs often change during the course of a project's development which can range from six months to a number of years. Thus, the main design specifications can not be completely laid out in advance. If a firm uses a strict waterfall methodology in this environment, it runs the risk of delivering a highly reliable bug free product without the functionality needed by customers. What is called for instead is some sort of iterative development process that allows one to incorporate user requirements during the development process. For a variety of reasons this is very difficult to develop, not least because of the common practice, not only in Japan, of outsourcing the writing of code. In summary, following the quality principle of pushing quality prevention upstream into the design stage inhibits the innovations needed to respond to changing customer needs during the course of software development.

Implications of Our Three Cases

Now we turn to the implications of our findings from our study of these three cases. In the case of the Internet protocol, TCP/IP, we saw that initially it did not match quality benchmarks of traditional universal voice service. Those engineers developing TCP/IP were able incrementally to add new features and improve reliability as one after another of its technical problems were gradually solved. However, neither the ability to solve these problems nor the rate at which these problems would be solved, were knowable in the early years of the Internet.

Under these circumstances engineers in incumbent firms, steeped in a strong quality culture, initially found this technology unacceptable and were slow to adopt it. High reliability firms, like telephone companies, have a great deal of difficulty of responding positively to technologies with these kinds of trajectories. This left the initiative, and gave competitive advantage, to those start ups which pushed ahead with TCP/IP.

The TCP/IP case is not unique. The many low QoS and reliability features exhibited by the early Internet are a common feature of disruptive technologies according to the well known research of Clayton Christensen (1997). Incumbent market leaders, he argues, have difficulty responding positively to these technologies which are often introduced in new and down markets where margins are low. Instead, incumbents are geared to supplying their existing customers with higher and higher value added quality products.

He cites many industry examples such as the response of incumbent U.S. steel leaders to the introduction of thin slab casting at steel mini mills in the early 1990s. The initial steel produced by this new methodology had low surface quality. The incumbent steel companies could not use it with their existing customers (e.g, appliance makers). Nucor, a start up and the leader in its introduction, successfully targeted less quality sensitive markets (Christensen, 1999:43). The leading firms were not interested in these markets with their lower profit margins. Over time, however, engineers at new firms like Nucor were able to incrementally improve reliability as they solved many of the new technology's problems. With this improvement, the use of thin slab casting products gradually moved up market challenging the incumbent steel makers in these markets.

The challenge that disruptive technology poses for incumbents is universal. Yet, it appears to have applied with special force in Japan. Japanese manufacturing firms are especially strong in producing high quality products based on capturing user needs. User-led innovation is a notable feature of the Japanese manufacturing sector relative to the U.S. (Mansfield, 1988:1771); Japanese top managers themselves often refer to this characteristic. Consider the 2004 statement by Machida Katsuhiko, Pres. Sharp Corp.

> Under the conventional approach to manufacturing, that is, user oriented product development that seeks to make improvements and fix complaints, it will be extremely difficult to come up with new hit products. Consumers are seeking products that give them a sense of wonderment and create a positive impression (http://www.watch.impress.co.jp/av/docs/20040108/sharp.htm).

When we speak of user-led innovation, we typically refer to current customers and the kind of innovation that is likely to result is incremental innovation. By being so focused on meeting user needs of current customers, however, Japanese firms are more likely to miss opportunities presented by radical/disruptive technologies that meet needs of different sets of customers, create new markets and offer totally new functionalities like the Internet (cf., Christensen, 1999: 96-99).

We turn now to the challenge posed by quality's relationship to first to market. Many Japanese firms would never think explicitly about trading off some quality for being first to market. Strict adherence to the simultaneous achievement of QCD (Quality, Cost Delivery) and "quality first" mantras limit strategic choices. Yet, in dynamic high tech markets, as a saw in the case of Cisco, a firm can get tremendous competitive advantage if they are able to get their products deployed first in the marketplace and then exploit the experience curve and set industry standards to deter late entering firms.

Researchers have long noted that at the beginning of a new technology's product cycle, early adopters are most interested in new functionalities (enabling them to do something they couldn't do before) rather than reliability or durability per se (Utterback,1994: 92-102).They are willing initially to tolerate some quality problems. This may be especially true in the hi tech sector (Moore, 1991). They understand that there will be some problems with new products. Kume Hitoshi, the Japanese quality expert, makes a related point noting that profit not quality is the goal early in the product cycle. Over time, however, competitors enter the market and match the functionality of the innovator. Gradually the basis of competition shifts to price and quality. Customers will begin to choose products that are more reliable from vendors which are deemed reputable. Firms begin to design products that meet the changing needs of existing customers, They focus on meeting user needs, especially lead users, and a trajectory of quality improvements is set in motion as firms improve their products and supporting services from one generation to the next (Christensen, 1999: 96-99).

Our software firm would never consider trading off quality to be first to market in their packaged products sales. Recall that their reliability reputation is central to their brand. By contrast, the former CTO of one the most successful and innovative U.S. software firms in Silicon Valley told us that he “ didn't know of any project (at our company) that ‘hasn't’ sacrificed quality in an effort to get functionality into a customers hands particularly if a competitor is on the horizon. There is always a trade-off and that trade-off is always reasoned about informally." We see two very different approaches, perhaps emblematic of U.S. and Japanese high tech executive thinking.

To be sure, there are circumstances in which the prudent decision would be to withhold a new product from the market until its quality problems are solved. Consider the recent case of Affymetrix. The company invented and dominates the commercial gene chip market. In late 2005, it unveiled a new generation chip but the product was released without sufficient testing and had flawed software. It took five months, a new software download, and delivery of new chips to fix the problem (Chase, 2006, B1). This disaster provided an opening for a fast charging start up, Illumina, which as a result gained market share at Affymetrix's expense. Afymetrix countered to regain market share subsequently with a large price reduction thereby reducing its profit margins. Clearly, it was a very expensive decision on Affymetrix's part to release this under tested product so early. They took dangerous risks and damaged their reputation. There can be high costs associated with letting a rival beat you to market with a new product but there may be even higher costs for beating them to market with a faulty unusable product.

On the other side, Apple allowed just 6 months product development time for its release of the first IPod in 2001, normally a product of this nature would have one year development time (Levy, 2006:105-106). But many firms were working on similar products and Apple wanted to be able to take advantage of the upcoming Christmas season. After almost 5 years, Apple reports that failure rates are currently running at "less than 5%" (Wingfield, 2006: Dl). This is not an enviable achievement. Yet, it is clear that the new functionality, ease of use and "cool" aesthetics of the new product, have more than outweighed the product's durability problems. Moreover, the IPod's durability is gradually improving with each now model and surveys show that users' satisfaction remains above those of competitors (Wingfield, 2006, Dl). Thus, Apple's decision to rush development, before having worked out all the IPod's durability problems, was justified as a business decision. How does a firm know if they have

Affymetrix's genotyping equipment or an Apple IPod on their hands? That is the strategic challenge and one to which we return below.

Still another challenge arises out of Japanese industry's overall success in raising its quality performance. This success owes much to the shift from downstream inspection of production processes to upstream prevention. This has been one of Japan's great contributions to the global quality movement. Ishikawa Kaoru, the recognized leader of the postwar Japanese quality movement describes the evolutionary process as follows:

> Because of the limitations of the process control oriented quality assurance, industry started to build quality into its products by performing careful evaluation at every stage of product development from new product planning through design to pilot production and by using the QC approach to investigate reliability in its broadest sense (Ishikawa, 1990:15).

There is little doubt that this new approach made a powerful contribution to quality assurance. However, it is also not hard to see that this approach, strenuously implemented, would make many companies more risk averse in approaching innovation. In our software case, their zero bug culture (stress on reliability) sometimes leads the firm to recommend to customers that they use older versions of applications rather than newer ones offering more functionality. One analyst observes that the firm developed a "corporate DNA" that places the highest priority on creating system stability. This leads them to give preferential treatment to products and techniques that have achieved satisfactory results in the past at the expense of the latest technologies.

If, very early in the product development process, a firm starts focusing on possible warranty claims or the lack of potential stability in production process, it has the potential to kill or delay many innovative projects (including use of new materials). Moreover, as we saw, in industries with a dynamic market and technology environment, building in quality early in the product development process may lead firms to fail to meet rapidly changing user needs.

There is an additional challenge posed by Japan's remarkable success in building its quality brand. Scholars generally discuss reputation positively, the better a firm's reputation for x (e.g., quality, environmentally friendly), the better it is for the firm (Eccles, Newquist and Schatz, 2006:104-114). But firms can become prisoners of their positive reputations and then it risks becoming a negative factor. We have already discussed ways in which a strong quality brand may slow a firm's introduction of innovative products.

One of the additional undesirable consequences of having a well earned reputation for high quality products is that firms may find it difficult to introduce lower quality products for selected markets. They behave this way because of fear that such products would damage their quality brand. Many of the growth markets of the future, however, are in the BRICs (Brazil, Russia, Indian and China) .To attack their mass markets often requires stripped down basic products that lack the value added quality featured by Japanese firms. Japanese auto firms for example find it hard to think of introducing cars to these markets without airbags. Apart from the ethical issues (which could be handled by making such equipment optional and leaving it to customers to choose), they are locked into a mode of ever increasing quality just as we described in the case of the DRAM firms. There is another sense in which Japanese hi tech firms may be prisoners of their quality achievements. The Japanese market is particularly demanding (both individual and business customers). As one manager said to us, "they (their customers) don't tolerate *any* failure." When these demanding standards are in synch with global market, meeting these standards can be a great launching pad for Japanese exports. When domestic customers are more demanding of their radically innovative products than overseas customers, however, it may make Japanese companies conservative and slow to introduce them.

Possible Solutions: Strategies and Tactics

We have described a variety of challenges which quality improvement may pose for radical innovation. A strong quality improvement culture may lead a firm to be unresponsive to technology and market developments that shift demand to reduced quality as in the case of the DRAM industry. A strong quality improvement culture with a focus on user led innovation for current customers may blind firms to new technologies and product features that would be attractive in new markets. In particular, a firm with a powerful reliability culture may not be receptive to new disruptive technologies that initially display poor reliability, as was demonstrated by NTT and the leading electronic firms' negative responses to the Internet protocol, TCP/IP. We also saw that a "no bug" culture, apparent in our software firm, can breed risk aversion and slowness in introducing new technologies. An inflexible emphasis on "quality first" may unreasonably slow time to market when introducing radical innovation. Building quality in upstream early in the product planning stage, a powerful formula for improved quality, nevertheless accentuates risk aversion when evaluating the potential for improvement of new products and materials. Locking in quality requirements early can be a special problem when there is rapid change in technology and markets during the product development process. User requirements may not be met under these circumstances. Overall, there is a danger that Japanese hi tech firms can become prisoners of their quality brand.

While we can't propose strategies and tactics to deal with all these challenges, we can make some observations. One can see it as a reasonable tradeoff for Japanese high tech firm to be leaders in incremental improvement and innovation while conceding the introduction of radical innovation to others. Japanese export oriented manufacturers have done quite well competitively emphasizing incremental user-led innovation over radical innovation. While researchers and managers continually search for ways that firms can be "ambidextrous" (Tushman, Anderson, O'Reilly:1997: 4-23), there may be fundamental *and intractable* contradictions between the capabilities and practices required for incremental versus radical innovation (March, 1991).

That said, in the spirit of those scholars and managers who advocate the need to build ambidextrous organizations that can both incrementally improve and truly innovate (Tushman and Anderson, 1986; Argote, 2005), we offer the following possibilities:

Japanese hi tech firms might consider making stronger use of beta testing as a way to ease into the market earlier without abandoning their high quality standards. Beta testing has become quite popular in U.S. over the last twenty years. Beta testing began in the computer industry, then spread to semiconductors and software by the late 1980s. By 1994, it as estimated that 50 percent of Fortune 500 companies had used beta besting and 20% used it regularly (Daly, 1994: 37). It is used, however, only modestly in Japan and not a large subject of large scale discussion within the quality community. Yet, for many consumer and even some business products, customers see great value in getting the new product as early as possible. For individuals, it might be to show off to their friends that they have the latest technology or to participate in shaping the product, and for firms so it can be to get access to a competitive weapon as early as possible or to shape the emerging product. Properly done, customers are told of the risks up front; this makes them less likely to blame the manufacturer for problems that might arise. This approach minimizes the risk of damaging a firm's quality brand resulting from too early release, while enjoying a number of benefits. For the firm, beta testing can provide early market intelligence about customer needs that helps shape the ultimate product. It is about intentionally exposing selected sophisticated users to error, an approach that doesn't come naturally to quality personnel. Beta products can also serve as a marketing tool to create a cachet about the product among early adopters (Chung, 2004).

A stronger version of beta testing involves releasing early versions of products to selected markets. Sharp Corp. is reported to release its LCD panels for commercial production when its yield (complex measure of both quality and productivity) reaches 60%. Samsung is said to release its LCD panels to selected markets when its yield reaches 20%. A Japanese analyst explained to us that it is only at 60% that quality standards are met and the product is economically viable (can produce profits). Is Samsung behaving irrationally releasing its product at 20% yield to selected markets like China? Not necessarily. By releasing the product early to selected markets, Samsung minimizes damage to the brand when problems surface. But it also gathers – just as with beta testing- valuable market intelligence that allows it to adjust the product to better meet user needs as well as to solve particular quality problems such as what level of defect is noticeable by viewers of LCD displays for specific applications. This early information gives them an edge on later entering competitors. We see this ability to gather market intelligence by using select customers to shape the product prior to widespread release, as part of a continuum. Key is choosing customers who will be representative of the target markets. On one end of the continuum would be a product like Wikipedia where the user community totally designs the product and has a sense of ownership of that product once it is released; at the other end are beta releases.

Earlier we discussed Japan as a prisoner of its quality reputation and the challenge this posed for Japanese firms trying to attack the rapidly growing BRICs markets. It is a challenge born of their very success in creating a high quality brand for their products. It is a particularly acute challenge because of new competitors from Taiwan, Korea, and above all China, which often appear more nimble and sensitive to user needs in these markets. One possibility is for Japanese firms to use subsidiaries, or develop separate brands, for developing more basic products for these markets and in this fashion meet market demand without diminishing their own quality reputation.

Lastly, one can pursue an approach that changes the focus of the quality attributes which are emphasized. With many innovative hi tech products, we have seen performance and features may be more important than reliability and durability in attracting customers at the beginning of the product cycle. While all are strictly speaking quality attributes, Japanese managers and consumers often see the latter as quality issues but not the former.

Consider in this context, our discussion of the IPod. There is no data to suggest that Apple intentionally downgraded reliability or durability. Nevertheless, in their rush to be first to market with a different kind of Mp3 player, they ended up sacrificing durability. Over time, we saw also that they gradually improved the device's durability, enough to ward off competitors. What if a firm pursued this kind of thinking intentionally and strategically? Can a firm determine in advance the benefits of being first to market relative to its competitors? Apart from short term revenue benefits, will the firm be able to use experience curve to maintain its lead over competitors? Does it know if it is a fast learner relative to competitors? Can it determine the probable costs of having "less than normal" reliability if it goes to market early? In the case of Affymetrix, could they not have anticipated the high potential costs of going to the market with an under tested product and an eager new entrant coming on market with a comparable product. If both the revenue and experience curve benefits of going to the market early are large and the costs of weaker than normal quality are judged to be manageable, a firm might well consider taking the risk of going to market early. The key is can the firm accurately learn about and assess these benefits and costs and is it able to accurately assess its learning capabilities relative to competitors. David Apgar (2006) calls these non-random "learnable risks" The challenge is not just to learn about risks – involving customers and technologies—but to understand a firm's risk assessment capabilities (both of the risk occurring and the likely costs and benefits should it occur). This allows a firm to makes its decisions based on knowledge of worst case scenarios. Key is whether the firm can learn about these risks and deal with them faster than competitors.

We have explored the ways in which the quality culture of Japanese high tech firms poses a challenge for innovation. We also offered up some exploratory views on how Japanese firms might meet this challenge. Above all, it calls for firms to think more strategically and flexibly about the role of quality at the early stages of the product cycle for high tech products. As it stands now, they display a strong tendency to consistently overestimate the risks of going to market early with radically new products of less than stellar quality.

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