STRATEGIC CONTROL SYSTEMS FOR QUALITY: AN EMPIRICAL COMPARISON OF THE JAPANESE AND U.S. ELECTRONICS INDUSTRY

Shirley J. Daniel* and Wolf D. Reitsperger*
University of Hawaii

Abstract. Management control systems should be designed to complement the strategies pursued. Few empirical studies, however, have focused on management control systems for quality control and zero-defect strategies. This study compares quality strategies and their relationships with management control systems in the Japanese and U.S. electronics industry.

The results indicate that the quality strategies of U.S. manufacturing managers reflect adherence to zero-defect philosophies more than those of the Japanese managers. However, fewer U.S. managers receive management control information to support these zero-defect strategies.

Tests linking quality strategies to management control information provide limited evidence that those U.S. managers who have adopted zero-defect strategies are more likely to receive modified management control information than U.S. managers who have not adopted zero-defect strategies. In contrast, the data suggest that Japanese managers are provided with goal-setting and feedback information about quality performance regardless of their adherence to a zero-defect versus a traditional quality management strategy, thus focussing workers' attention on continuous quality improvement.

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*Shirley Daniel and Wolf Reitsperger are presently professors at the College of Business Administration at the University of Hawaii at Manoa. Both are involved in directing the international business activities of the business school. Shirley Daniel holds the co-directorship of the Center for International Business Education and Research (CIBER). Wolf Reitsperger is the director of the Pacific Asian Management Institute (PAMI). Their present research interest focuses on comparative strategy, strategic control systems and their relationship to financial performance. Dr. Daniel received her Ph.D. from Oklahoma State University. Dr. Reitsperger received his Ph.D. from the London School of Economics.

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The strategic management literature advocates the establishment of a system of strategically focused management controls to monitor progress and ensure the implementation of strategic plans (see Govindarajan and Gupta [1985]; Hrebiniak and Joyce [1984]; Lorange [1982]; Lorange et al. [1986]). Goold and Quinn [1990, 43] describe a strategic control system as

> the process which allows senior management to determine whether a business unit is performing satisfactorily, and which provides motivation for business unit management to see that it continues to do so. It therefore normally involves the agreement of objectives for the business between different levels of management; monitoring of performance against these objectives; and feedback on results achieved, together with incentives and sanctions for business management.

This view emphasizes the development of objectives as a prerequisite of the system, followed by the implementation of specific goal and feedback systems to complement the objectives. Thus, the primary purpose of management control systems is to support strategy by providing information to management for planning, control and decisionmaking.

While the normative view assumes that management controls should complement strategy, only a few empirical studies have focused on the link between strategy and management control systems. The literature suggests that in practice, few companies identify or build strategic controls into their systems [Goold and Quinn 1990]. Furthermore, the traditional management accounting systems which are commonly in place have been strongly criticized as being inadequate to meet the needs of modern manufacturing and failing to provide information consistent with corporate strategic goals [Hayes and Abernathy 1980; Kaplan 1983, 1984; Howell and Soucy 1987].

The primary impetus for much of the criticism of management accounting has been U.S. manufacturing's loss of a competitive edge to Japan. However, only a few empirical studies have tackled comparisons of management accounting practices between these two countries [Daley et al. 1985] and only single-country studies have examined the link between management accounting practices and manufacturing strategy (see Daniel and Reitsperger [1991]). In addition, hardly any empirical evidence has focused on the implementation of Japanese manufacturing strategies through management control systems, and very little is known about whether U.S. manufacturers lack such controls.

Ancedotal evidence indicates that Japanese companies shape management control systems to complement corporate strategy [Monden and Sakurai 1989; Kawada and Johnson 1993]. Hiromoto [1988] observed that the management accounting systems of Japanese manufacturers have been modified to support corporate strategy, particularly in production and capital acquisition decisions. Additional empirical research on this topic is essential to promote a better understanding of the interaction of innovative manufacturing strategy and strategic control systems.

This study provides empirical evidence about quality strategies in the U.S. and Japan, and the management control systems used to implement them. It focuses on high volume repetitive assembly electronics manufacturing, an industry in which the Japanese have successfully gained global competitive dominance.

THEORETICAL BACKGROUND

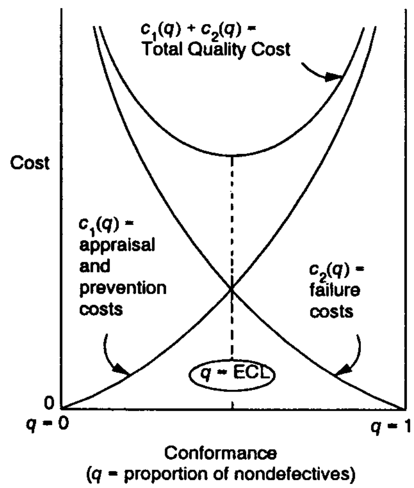
Quality Strategy

Strategies denote actions or patterns of actions intended for the attainment of goals. Manufacturing strategy is part of the widely accepted hierarchy of strategy suggested by Hofer [1975] and Hofer and Schendel [1978]. While manufacturing strategy theory is only now evolving, its major components have been identified by operations management writers, such as Skinner [1969], Wheelwright [1978, 1984], Miller [1981], Buffa [1984], and Hayes and Wheelwright [1984]. The manufacturing literature has identified four dimensions of manufacturing strategy: cost, quality, flexibility and dependability (see Buffa [1984]; Wheelwright [1984]; Schmenner [1987]; Swamidass and Newell [1987]). A focus on quality has been widely accepted as a cornerstone of Japanese manufacturing strategy [Wheelwright 1981; Burnham 1985; Feigenbaum 1986; Reitsperger 1986]. A strategic focus on quality aiming at continuous improvement has been found to result in cost and productivity improvements [Feigenbaum 1986, 29; Schonberger 1982; Wheelwright 1981] and a better product appeal in a market with increasing quality expectations [Barksdale et al. 1982; Schonberger 1982, 82]. Quality has clearly emerged as a key issue in building and maintaining a sustainable competitive advantage.

Traditionally, quality control practices in U.S. manufacturing have been guided by the economic conformance level (ECL) model (see, for example, Lundvall and Juran [1974]; Chase and Acquilano [1981]). This model proposes a cost minimizing quality level which is achieved by balancing prevention and appraisal costs against internal and external failure costs. Theoretically, the optimal economic conformance level, the proportion of non-defective products at which total costs are minimized, is the point at which marginal prevention and appraisal costs equal marginal failure costs. According to the model, the economic conformance level would never occur at a zero-defect level (see Figure 1).

Quality control practices applied by Japanese manufacturers deviate from the ECL model by prescribing zero defects as the optimal conformance level [Crosby 1979; Deming 1982], proposing that increasing conformance is always less costly, up to and including a zero-defect level. Advocates of the zero-defect model point to evidence that a variety of Japanese manufacturers have achieved both higher quality and lower costs than their American competitors by applying a quality strategy of continuous improvement with

FIGURE 1
The Economic Conformation Level Model



a goal of zero defects [Garvin 1988, 1983; Abernathy et al. 1981; Hayes and Clark 1985; Ferdows and DeMeyer 1990].

The operational aspects of the ECL and the zero-defect quality strategies assume different behavior patterns for manufacturing costs. The ECL model emphasizes smooth continuous production runs as the essence of cost effective production. Thus, line stops are discouraged and the responsibility for quality is placed in the hands of staff specialists, allowing assembly line personnel to focus on meeting production output goals. The focus is on static optimization, minimizing the total manufacturing costs associated with quality prevention and failure assuming a static production process.

Conversely, the zero-defect strategy assumes no trade-off between improved quality and total costs. Assembly personnel control quality and workers are encouraged to stop the assembly line rather than allow defective units to be produced. The focus of this strategy is defect prevention, with smooth continuous production a secondary goal after quality is achieved.

U.S. manufacturing has been harshly criticized for "getting the goods out the door" at the expense of quality. Japanese manufacturers, on the other hand, have been praised for their strong focus on quality and the development of zero-defect quality strategies. While much anecdotal evidence is available supporting these views of Japanese and U.S. quality strategies [Hayes and Abernathy 1980; Hayes 1981; Wheelwright 1981], little empirical testing has been done.

Management Control Systems to Support Quality Strategy

Effective strategy implementation requires integration with operational planning and control. Gage [1982] emphasizes the importance of the fit between strategy and control systems:

> The operational plan should be completely consistent with and in the context of the strategies involved. The control activities should be related directly to this operational plan. Thus, the day-to-day managing of the business relates back to the strategic plan. Indeed, unless this coupling exists, the strategic plan will become irrelevant with time.

Since ECL and zero-defect quality strategies require different operational behavior and assume different relationships between quality costs and total manufacturing costs, different management control systems are needed to support their implementation. Traditional cost accounting practices have supported the application of the ECL strategy through the use of standards for labor, material and overhead costs that include scrap and the added labor and equipment needed to produce at defect levels greater than zero. Once such standards are established, the costs of excessive internal failure are indirectly measured through variances [Kaplan 1988], while prevention and appraisal costs are more likely to be budgeted and allocated as part of overhead. Detailed information to monitor the elements of quality cost is not generally available in traditional standard cost reports, reflecting the static nature of the ECL model. Since the standards are considered optimal, there is no focus on continuous improvement.

Quality reporting systems detailing budgeted and actual figures for prevention, appraisal, internal failure and external failure costs are now being advocated by some researchers [Morse, Roth and Poston 1987; Howell and Soucy 1987]. The proponents of these new quality cost reporting systems suggest that they might be helpful to management in correcting imbalances between the sum of prevention and appraisal costs and the sum of failure costs. These researchers fall short of wholeheartedly embracing the ECL model, however, since the pursuit of zero defects may lead to technological breakthroughs that shift the cost curves downward, thus changing the ECL [Morse et al. 1987, 32].

However, a pure zero-defect strategy does not accept a trade-off between prevention and failure costs. A quality reporting system that implies an acceptable trade-off between various quality costs measured in the short term would be unacceptable to zero-defect advocates who believe that increased attention to the prevention of defects will, in the long run, always lead to a decrease in total costs. Further, the indirect costs of poor quality may be several times the direct measured costs of scrap, rework and warranty (e.g., Kaplan [1988]; Rehder and Ralston [1984, 25]). There is evidence that there is a keen understanding of this quality-cost relationship in Japanese firms [Wheelwright 1981]. Therefore, periodically quantifying cost figures for quality could be an unnecessary and possibly even misleading exercise.

Continuous improvement and striving for perfect quality performance are the essence of zero-defect quality management. Thus, a management control system to support a zero-defect strategy would likely focus the efforts of production personnel on continuously reducing the number of defective units, by providing specific, challenging goals and performance feedback about quality [Locke et al. 1981].

As previously stated, zero-defect advocates focus on continuous quality improvement because they believe that in the long run, decreasing defects will be economically beneficial. To zero-defect advocates, short-run cost figures may carry less significance since they cannot capture all the benefits of improved quality, such as reduced warranty costs and increased market share. Management control systems supporting zero-defect quality strategies consequently are more likely to provide unit rather than cost information for quality to production personnel [Kaplan 1988].

RESEARCH METHOD AND SAMPLE DESCRIPTION

Sample Selection

One of the objectives of this study was to obtain a broad-based empirical data set of Japanese and U.S. manufacturers to shed much-needed light on implementation issues in quality management. A sample of high volume repetitive assembly electronics manufacturers were selected from the First and Second Sections of the Tokyo, Osaka and Nagoya stock exchanges using the *Japan Company Handbook*. Similar U.S. manufacturers were selected from the *Standard and Poor's Corporation Directory*.

A packet of twenty questionnaires was mailed to each company with a cover letter explaining the study and requesting that the questionnaires be distributed to various levels of manufacturing managers. Manufacturing managers were defined as foremen, section managers, department heads and production managers. Top managers such as factory managers, company presidents and vice presidents were also included in the survey. A total of 1468 responses were received, 679 from Japan and 789 from the U.S. Response rates for both firms and managers are shown in Table 1. Individual managers were chosen as the unit of analysis since tests revealed that company differences accounted for only 10% to 20% of the variation in the strategy variables and only 10% to 30% of the variation in the goal and feedback variables.

Non-response bias tests were conducted comparing the participating firms with a similar sample of firms who originally did not respond, but were personally contacted and persuaded to participate. No significant response bias was found. We also compared the responding firms to the population of electronics firms on the Compustat and Nikkei data tapes, respectively, for size and profitability. The findings revealed that the participating firms were somewhat larger than the population distribution would predict, but no other differences were found. We therefore, feel that the non-response bias in the study is minimal, but the results may be more typical of larger manufacturing firms than the population as a whole.

TABLE 1
U.S. and Japan Electronics Managers

	Japan		U.S.	
	Firms	Managers	Firms	Managers
Questionnaires Sent	208	3574	711	13150
Reponses	50	679	64	789
Response Rate	24%	19%	9%	6%

Instrument and Measures

The questionnaire had two sections. The first gathered information concerning quality strategies and the second addressed goal and feedback information for quality internal failures provided by the management control system.

The questionnaire was developed in the English language then translated into the Japanese language by a translator familiar with both the language and the research area. A translation back into the English language was performed to ensure the accuracy of the translation. Comparison of the original English version and the reverse translation revealed no significant differences. The instrument was then pretested at several manufacturing firms in the U.S. Silicon Valley and then reviewed for clarity by two English-speaking Japanese managers before it was used.

Quality Strategy Measures

The quality strategies of the participants were measured by their agreement or disagreement with eight statements relating to quality-cost trade-off decisions and the locus of responsibility for quality. These two issues describe the essence of the differences between the zero-defect quality strategy and the traditional ECL quality strategy. The implementation of policies concerning these two issues measures the manager's commitment to either strategy. The questionnaire was designed such that agreement with each statement, indicated by a lower score, reflected adherence to an ECL strategy, while disagreement, indicated by a higher score, reflected adherence to a zero-defect strategy. The questions are listed in Table 2 along with the mean, median and standard deviation of the responses. Cronbach's *alpha* was computed to assess the homogeneity and consistency of the items in the measure. The *alpha* values of .64 for Japan and .82 for the U.S. are acceptable for a new instrument measuring a complex construct.

Management Control System Measures

The management control portion of the questionnaire focused on goal setting and feedback for quality internal failures and downtime (see Table 3). Rejects, rework and scrap were chosen because they should be readily

TABLE 2
U.S. and Japanese Electronics Managers Quality Strategy

		Wilcoxon Scores		Mean*	Median	Std. Dev.
QUALCOST	Reducing defective goods in customer deliveries means higher cost.	15.42	U.S.	4.39	5.00	.886
		(.0001)	Japan	3.59	4.00	1.039
REPQUAL	The key responsibility for maintaining quality standards should rest with the quality assurance department or other specialized staff groups.	9.76	U.S.	4.39	5.00	1.035
		(.0001)	Japan	3.87	4.00	1.028
USE AQL	Operating on the basis of AQL's (Acceptable Quality Level system) is the best way to assure that the customer gets what he wants.	10.64	U.S.	3.66	4.00	1.133
		(.0001)	Japan	3.08	2.00	1.009
YIELD FOCUS	We should concentrate on yields (ratio of acceptable products to total products produced) rather than on defective products produced.	1.55	U.S.	3.82	4.00	1.110
		(.1212)	Japan	3.74	4.00	1.117
NO LINE STOP	When facing a quality problem on the line, line speed should be maintained at a fixed rate, and the quality problem should be corrected by specialized repair personnel at the next stage of production.	12.94	U.S.	4.43	5.00	.838
		(.0001)	Japan	3.67	4.00	1.162
TAKEOVER	The complexity and multitude of factors affecting quality performance justifies an occasional "take over" of troubled operations by highly qualified staff rescue teams.	19.47	U.S.	3.23	3.00	1.212
		(.0001)	Japan	2.12	2.00	1.005
ACCEPT OFF-QUALITY	The threat and cost of a line stoppage justifies an occasional acceptance of slightly "off quality components" from suppliers.	-10.72	U.S.	4.08	4.00	1.015
		(.0001)	Japan	4.54	5.00	.736
DELIVER OFF-QUALITY	The delivery deadline of an important customer should be met to "save" an order despite being slightly below specifications when it is clear that such action will not result in quality problems for the customer.	-0.64	U.S.	3.56	4.00	1.139
		(.5218)	Japan	3.58	4.00	1.015

*1=Strongly agree, 5=Strongly disagree

TABLE 3
Goal-Setting and Feedback
U.S. and Japanese Electronics Managers
Quality Goals and Feedback

Information Variable		Goal-Setting: % Managers Receiving Goals	Goal-Setting: *Chi*-square Statistic & Significance	Feedback: Mean*	Feedback: Median	Feedback: Wilcoxon Z Significance	Combined: Spearman Rank Correlations between Goals and Feedback
Rejects	U.S.	37	202.9	3.26	4	0.6387	
	Japan	70	(.000)	3.20	3	(.5238)	.4862
Reject Cost	U.S.	18	153.47	2.02	1	-6.1242	.5334
	Japan	45	(.000)	2.29	3	(.0000)	.7085
Rework	U.S.	24	30.13	2.60	3	2.1223	.4858
	Japan	34	(.000)	2.34	2	(.0338)	.7141
Rework Cost	U.S.	14	38.75	1.85	1	-1.8080	.5061
	Japan	25	(.000)	1.89	1	(.0706)	.6800
Scrap	U.S.	28	6.77	2.53	3	6.8705	.4820
	Japan	31	(.009)	2.00	2	(.0000)	.6606
Scrap Cost	U.S.	27	10.04	2.40	3	6.3250	.4942
	Japan	32	(.002)	1.95	2	(.0000)	.6861
Downtime	U.S.	13	81.51	2.08	1	-5.5808	.4781
	Japan	31	(.000)	2.37	2	(.0000)	.6735
Downtime Cost	U.S.	1	62.05	1.43	1	-8.5920	.4819
	Japan	18	(.000)	1.78	1	(.0000)	.6215

*6=more than daily, 5=daily, 4=weekly, 3=monthly, 2=less often, 1=never

available and understood by both assembly line workers and upper management. These measures would also be more likely to be elements of a quality management control system for either an ECL quality strategy or a zero-defect quality strategy.

Downtime was included since the choice between stopping the line to prevent defects and striving for smooth continuous improvement epitomizes the difference between the zero-defect and the ECL quality models. In a zero-defect quality strategy, line stops are preferred to producing defective products. In the early stages of such a quality improvement program, excessive downtime may be experienced as previously unknown sources of quality problems are discovered. But as quality conformance improves, downtime should decrease. Therefore, downtime provides a measure of progress toward a zero-defect manufacturing environment. Space was also provided for respondents to add goal and feedback measures that were not listed on the questionnaire.

For each quality item, respondents were asked to indicate whether they received target figures (goals) regularly. They were then asked to indicate how often actual performance figures for each quality feedback item were provided to them by checking one or more of six frequency categories: more than once daily, daily, weekly, monthly, less often or never. Each quality control information item was listed in unit and monetary terms to test the use of cost as well as unit information in quality reporting. The Cronbach *alphas* for the eight goal setting and eight feedback variables ranged from .83 to .93, which indicate a high degree of consistency and homogeneity among the measures.

RESULTS

Quality Strategy

The literature on Japanese quality management has implied that, in general, Japanese managers strongly adhere to zero-defect quality strategies while U.S. manufacturers follow the "quality is costly" approach associated with the ECL model (e.g., Schonberger [1982]; Hayes [1981]). As expected, our results indicate that the majority of Japanese managers are zero-defect advocates. Contrary to expectations, an even greater majority of U.S. managers proved to be zero-defect proponents. The median responses and the tests of means for the quality strategy questions indicate significant differences between the U.S. and Japan on six of the eight questions (Table 2). Five of these differences indicate significantly greater support for zero-defect strategies in the U.S. than in Japan.

There is, however, one extremely important issue about which the Japanese managers are adamant. They are more willing than U.S. managers to stop a line rather than accept off-quality components into the manufacturing process. The willingness of U.S. managers to compromise on this issue and accept substandard parts and components may be a key factor contributing to the difficulty U.S. manufacturers have in meeting the quality levels of their Japanese competitors.

Another interesting finding is the considerable proportion of Japanese managers who advocate using Acceptable Quality Levels, a tool of the traditional ECL quality control model. Many Japanese managers believe that AQL's are useful in controlling quality for some processes. Other answers in Japan are contrary to what was expected, indicating that substantial proportions of Japanese managers agree with the occasional takeover by staff specialists when quality problems occur. While this is counterintuitive in the context of a zero-defect strategy, other structural differences, like a fluid relationship between Japanese staff departments and operations personnel may make acceptance of staff involvement more palatable.

Overall, the majority of managers in both countries adhere to zero-defect strategies, with significantly stronger proponents in the U.S. than Japan.

Quality Goals

We expect a zero-defect strategy to be operationalized via specific subobjectives relevant for managing quality. Table 3 provides the percentage of the participating managers regularly receiving goals for rejects, rework, scrap and downtime and the *chi*-square tests for significant differences between Japan and the U.S. Significant differences exist for every variable. More Japanese managers are provided with quality goals than are U.S. managers, although quality goal-setting is practiced by only a minority of managers in both countries. The percentages indicate that the control of reject units is the predominant focus of quality goal-setting for both Japanese and U.S. managers. Most of the goals in cost terms are less frequently reported than their unit counterparts, but there are still more Japanese than U.S. managers receiving cost goals as well.

A management control system supporting a zero-defect strategy is more likely to include the provision of quality goals than the system supporting an ECL strategy. Support for this statement would be reflected in significant positive correlations between the quality strategy variables and quality goal variables. Spearman rank correlation coefficients were computed to relate the participants' responses for the eight quality strategy variables with goal provision. Separate analyses were performed for the U.S. and Japan in light of the significant differences in goal-setting between the two countries. Table 4 shows the strategy and quality goal variables that were significantly correlated.

Based on the literature and the high proportion of Japanese managers in our sample receiving goals for reject units, we expected many significant positive relationships in Japan between the quality strategy statements and the provision of goals for reject units. However, few such significant correlations were found. The high percentage of Japanese managers receiving goals for reject units and the insignificant correlations between strategy and reject unit goals in Japan lead to the conclusion that reject unit goals are widely used by the majority of participating Japanese managers, whether they adhere to zero-defect or ECL quality strategies. Significant correlations between quality strategy and goal-setting in Japan involved reject cost, rework cost and scrap cost goals and the issue of the trade-off between quality and cost. Contrary to our initial reasoning, this implies that Japanese managers who receive quality goals in cost terms do not equate higher quality with higher costs.

In the U.S., several strategy issues seem to be strongly related to the use of quality goal-setting information. *RESP QUAL* and *USE AQL* were significantly correlated with goals for reject units and cost, scrap units and cost and rework cost. *NO LINE STOP* was also significantly correlated with reject, rework and scrap unit goals. This indicates that U.S. managers who disagree with (a) operating on the basis of *AQL's* (acceptable quality levels), (b) accepting off-quality components to avoid a line stop, and (c) placing the responsibility for quality with specialists rather than line personnel (all reflecting a zero-defect strategy) more often receive regular quality goals.

In total, ten significant correlations were found in the Japanese data, all in the predicted direction, and twenty-two significant correlations were found

TABLE 4
U.S. and Japanese Electronics Managers
Quality Strategy with Quality Goals
Spearman Correlations

Quality Strategy		Quality Goal Item							
		Reject	Reject $	Rework	Rework $	Scrap	Scrap $	Downtime	Downtime $
QUALCOST	U.S.	—	AA	—	—	—	A	—	—
	Japan	—	JJ	—	JJ	—	J	—	JJ
RESPQUAL	U.S.	AA	AA	AA	AA	AA	AA	A	—
	Japan	—	—	—	J	—	—	—	—
USE AQL	U.S.	AA	AA	—	AA	AA	AA	—	—
	Japan	—	—	—	—	—	—	—	—
YIELD FOCUS	U.S.	—	A	—	A	—	—	—	—
	Japan	—	—	—	JJ	—	—	—	JJ
NO LINE STOP	U.S.	AA	—	A	—	AA	A	—	-A
	Japan	—	—	—	—	—	—	—	—
TAKEOVER	U.S.	—	A	—	—	—	—	—	—
	Japan	—	—	—	—	—	—	—	—
ACCEPT OFF-QUAL	U.S.	—	—	—	—	—	—	—	—
	Japan	—	—	—	—	—	—	—	—
DELIVER OFF-QUAL	U.S.	—	—	—	—	—	—	—	—
	Japan	J	—	—	—	—	—	JJ	J

A or J: significant at the .05 level; AA or JJ: significant at the .01 level in the U.S. data, with only one (downtime), having an unexpected negative sign. Overall, we observe a positive direction of the great majority of the correlations, the absence of significant negative correlations, and occurrence of a greater-than-chance number of significant positive correlations, supporting a congruence between quality strategy and management controls in the U.S. We also note that the link between strategy and information systems is stronger for the U.S. than Japan, despite the higher proportion of Japanese managers receiving goals. Put in another way, regardless of the quality strategy adopted, Japanese managers are more likely to be provided with specific quality goals.

Quality Feedback

A strategic control system should provide feedback on results achieved to allow management to monitor progress toward the stated objectives. The frequency of quality performance feedback provided to the participating U.S. and Japanese managers is summarized in Table 3. Wilcoxon rank sum tests indicate significant differences between the U.S. and Japan for all items except reject units and rework costs. Consistent with the goal provision findings, reject units are the most frequently provided feedback in both countries, with most participants receiving such feedback at least monthly. Most cost feedback items are provided less frequently than their unit counterparts. The median frequencies indicate that performance feedback is more frequent in Japan for reject cost, and downtime, while the U.S. provides more frequent feedback for rework units and scrap units and cost. This could imply that Japanese manufacturers are focusing on the prevention of defects and controlling costs while the attention of U.S. managers is drawn to rework and scrap which occur as a result of poor quality.

Management control systems supporting a zero-defect strategy should include more frequent quality feedback than a system supporting an ECL strategy. Support for this proposition would be reflected by significant positive correlations between the quality strategy variables and the feedback provision variables. The great majority of the significant Spearman rank correlations, designated by A's and J's in Table 5, are in the expected direction, with only two correlations, between the downtime feedback items and *NO LINE STOP* in the U.S., showing significant negative correlations. The twenty-eight significant correlations found in the U.S. data are significantly greater than chance, providing support for congruency between quality strategy and controls in the U.S. Nine significant correlations were found in the Japanese data, providing only weak support for a positive relationship between zero-defect strategy and the frequencies of quality feedback.

These results also indicate that differences in feedback provision in Japan and the U.S. are less pronounced than differences in goal-setting (Table 3). The primary feedback areas in which the U.S. is "ahead" are rework units and scrap units and cost, which are related not to prevention, but to the

TABLE 5
U.S. and Japanese Electronics Managers Quality Strategy with Quality Feedback Spearman Correlations

Quality Strategy		Quality Feedback Item							
		Reject	Reject $	Rework	Rework $	Scrap	Scrap $	Downtime	Downtime $
QUALCOST	U.S.	—	AA	—	A	A	AA	—	—
	Japan	—	—	—	J	—	—	—	—
RESPQUAL	U.S.	AA	AA	AA	AA	AA	AA	—	—
	Japan	—	—	—	—	—	—	—	—
USE AQL	U.S.	AA	AA	—	A	AA	AA	—	—
	Japan	—	—	—	—	—	—	—	—
YIELD FOCUS	U.S.	—	A	—	—	—	—	—	—
	Japan	—	—	—	JJ	—	—	—	J
NO LINE STOP	U.S.	A	—	—	—	—	—	A	A
	Japan	—	JJ	—	J	—	—	—	—
TAKEOVER	U.S.	—	A	—	—	—	—	—	—
	Japan	—	—	—	—	—	—	—	—
ACCEPT OFF-QUAL	U.S.	AA	A	—	—	—	—	—	—
	Japan	—	—	—	—	—	—	—	—
DELIVER OFF-QUAL	U.S.	AA	AA	—	—	A	A	AA	AA
	Japan	J	—	—	J	—	—	JJ	J

A or J: significant at the .05 level; AA or JJ: significant at the .01 level consequences of a lack of prevention. Thus, rework and scrap are special problem areas in the U.S., while the focus in Japan is on preventing rejects, monitoring downtime, and not accepting defective components in the first place. Again the correlations indicate a somewhat stronger congruency in the U.S. between zero-defect quality strategies and the feedback systems used to implement such strategies. The lack of significant correlations in Japan, when viewed in light of the frequency of feedback provided as shown in Table 3, may again indicate that regardless of the quality strategy adopted, Japanese managers are provided with feedback that focuses their attention on quality improvements.

Unit versus Cost Information

Based on the review of the literature we expected more significant correlations between a zero-defect strategy and the use of unit rather than cost information in the management control system. Table 3 indicates that while unit information is provided more frequently than cost information, there is no strong linkage between a zero-defect strategy and unit versus cost information in either the U.S. or Japan. Tables 4 and 5 show an approximately equal number of significant correlations between zero-defect strategies and the use of quality unit and quality cost goals and feedback. In fact, rework cost information is more significantly correlated with a zero-defect strategy than rework unit information in both Japan and the U.S. This leads to the conclusion that cost information for internal failures is important to zero-defect proponents in both the U.S. and Japan. This is consistent with the findings of Daley et al. [1985] who found a strong emphasis on cost performance measures in Japan.

Other Observations

Research has shown that only when specific goals are combined with feedback is performance effectively improved. A large body of research exists that indicates that feedback without specific goal-setting does not result in performance improvement [Locke et al. 1981]. Table 3 shows the Spearman rank correlations between goal-setting and feedback for Japan and the U.S. The Japanese correlations are significantly higher in every case except reject units, for which the Japanese correlation is only slightly higher than the U.S. This indicates that as a whole, Japanese managers are more likely than U.S. managers to receive the combined goal-setting and feedback information that is essential to performance improvement, and that U.S. management control systems are particularly lacking in the provision of specific goals for quality.

In addition, other data collected in the study indicates that goals for rejects, yields and other productivity measures are upgraded or tightened more frequently in Japan than the U.S. This is further empirical support for the notion that Japanese manufacturers have a strong focus on continuous improvement and are implementing this through effective goal-setting.

DISCUSSION

The major aim of this study was to compare quality strategies and management control systems in the U.S. and Japan. One of the most surprising findings of the study is that the U.S. electronics managers have adopted zero-defect philosophies even more fervently than the Japanese themselves. This finding is contrary to the literature of the 1970s and early 1980s, which suggests that the majority of U.S. managers operate on the basis of the ECL model, and indicates that significant changes have occurred in the way quality is viewed in the U.S. There do seem to remain significant difficulties in fully supporting a zero-defect philosophy in the U.S. when it comes to refusing off-quality components from suppliers, however. This may indicate a lack of control over suppliers in the U.S. vis-à-vis Japan. In Japan, large manufacturers are frequently able to dictate quality programs to their suppliers and subcontractors. Contracts specifying the right to return, at the expense of the supplier, when shipments contain defective goods are not uncommon.

While U.S. manufacturing strategies have moved toward an ideal "Japanese" pattern, management control systems for quality show mixed results. Some U.S. manufacturers have modified their management control systems for quality, especially by providing more quality performance feedback. This provides some support for the normative theory that management control systems should be a reflection of strategy. A higher number of linkages were found between quality strategies and management control information for quality in the U.S. than Japan. This indicates that some U.S. firms may have taken to heart the strategic management literature that advocates the practice of strategic controls [Govindarajan and Gupta 1985; Hrebiniak and Joyce 1984; Lorange 1982; Lorange et al. 1986].

On the other hand, the lack of significant correlations between strategy and control systems in Japan coupled with the greater provision in Japan of goal-setting and combined goal-setting and feedback information, indicates that the Japanese may have adopted a "generic" quality strategy focusing simply on continuous improvement of quality and processes rather than on the philosophical aspects of the zero-defect or ECL strategies. This indicates a pragmatic approach and a greater focus on implementation and results than on "indoctrination." Our findings suggest that the superior quality attributed to many Japanese manufactured products is supported by the application of motivational techniques developed by western social science that have focused the attention of workers on reducing quality failures. Widespread provision of specific goal-setting for quality in Japan, coupled with frequent feedback may be a primary contributor to the superior quality of Japanese manufactured products. The more frequent revision and upgrading of quality targets in Japan is also testimony to their long-term commitment to quality, achieved by incremental improvements.

Contrary to our expectations, support was not found for the proposition that zero-defect proponents focus primarily on unit information under a "quality is free" ideal rather than on the cost of quality internal failures. The provision of management control information concerning the costs of rejects, rework, and scrap were significantly related to a zero-defect strategy, especially in the U.S. In addition, the fact that quality cost figures are provided to more Japanese than U.S. managers implies that cost accounting plays a more important role in Japan than was previously thought [Dilworth 1985]. This is consistent with interviews with Japanese factory managers and accountants. Factory accountants in Japan are very responsive to operating management's requests for information, and communication between production managers and accountants is frequent and open. During our visits to several factories in Japan, we repeatedly found that cost accounting information was closely monitored by operating managers and that achieving cost reductions was of primary importance in the planning and goal-setting process. Regular "cost-down" meetings are held for the sole purpose of finding ways to decrease manufacturing costs. Again the focus in these meetings is on continuous improvement.

Our findings have both troublesome and promising implications for accountants and those involved in designing management control systems in the U.S. The extreme lack of specific goal-setting for quality in the U.S. relative to Japan poses a question about the focus of our management control systems. For many variables, virtually twice as many Japanese managers receive goal-setting information than their U.S. counterparts. In the area of feedback, the U.S. is not so far behind. However, research on the use of goal-setting and feedback indicates that providing feedback without specific goals does not result in improved performance [Locke et al. 1981]. The combined goal-setting and feedback variables indicate that Japan may have an edge by focusing on improvement, which in turn results in process changes and learning, while the U.S. is still focusing on past performance. Our findings suggest a need to adjust U.S. management control systems to provide a greater emphasis on continuous improvement toward the quality strategies managers have already embraced conceptually in this country. U.S. manufacturers could easily implement increased goal-setting to complement the feedback systems that already seem to be in place. Many U.S. manufacturers have adopted zero-defect quality strategies, and the implementation of specific goal-setting to support the continuous improvement process seems overdue. U.S. manufacturers must recognize that quality excellence cannot be achieved through simple solutions, or the adoption of zero-defect slogans. Continuous improvement, with zero defects as a long-term goal, requires hard work with the utilization of a series of ever-changing shorter term goals allowing for some defects as we strive to achieve perfection. When taking into account the previous research on goal-setting and feedback, the U.S. may reap significant benefits by focusing on increased goal-setting in the manufacturing process.

LIMITATIONS AND SUGGESTIONS FOR FUTURE RESEARCH

The presented research results are based on data from large U.S. and Japanese samples of electronics manufacturers using high volume repetitive assembly processes. The findings and conclusions of our research consequently need to be considered as industry and process specific. Future studies are needed to test the general applicability of the presented results, by comparing management control systems in a wider spectrum of industries.

Our study related desirable actions concerning quality with the actual provision of goals and feedback. This may partially explain the lack of correlation between strategy and controls that we observed. Future studies should focus on the question of why intended strategic changes are not implemented, especially in the U.S. The effects of specialist orientations, traditional management accounting practices, and attitudes need much more research attention since they seem to be significant barriers to the establishment of systems that strive for continuous improvement. The effect of new manufacturing strategies and control systems on performance is also an area that merits further research.

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