Quality Control Circles in Construction

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Abstract: Total quality control (TQC) programs have been responsible for improved labor motivation, production, and product quality in Japan. Quality control circles, as part of a TQC program, are a rather new participative management technique that merits study and analysis. A brief history of quality circles (QC) is given and QC program implementation is described briefly. The differences between manufacturing industries, where the circles have been originally implemented, and the construction industry are discussed. QC applications in Japanese construction companies are reviewed and the cultural and organizational differences between the Japanese and United States construction industries are addressed. A number of guidelines are recommended for the implementation of quality circles in a United States construction company. It is believed that if used correctly and efficiently, QC programs can work in the construction industry and can improve productivity, motivation, and quality.

Introduction

Productivity in the United States Construction industry has declined considerably in the past decade (Stoke 1980, Business Roundtable 1982). Research is going on to identify the causes of this decline and to recommend methods to improve productivity (Borcherding 1976; Maloney 1978, 1981; Parker 1980). At the same time, Japan's industry has been very successful in the international markets. Japanese management philosophy and methods merit study and analysis.

The Japanese total quality control (TQC) system, introduced in the 1950s and developed during the past three decades has played an important role in promoting that country to an international industrial power. Quality circles is a problem solving and industrial management concept in which employees from all hierarchical levels meet to discuss their problems, isolate them, and find solutions. It is a bottom-up approach to problem solving (Kusayanagi and Hatley 1984).

In this paper, a brief history of the evolution of quality circles (QC) in Japan will be given, and then the concept and procedure for a typical implementation will be addressed. The differences between manufacturing industries and the construction industry will be discussed. The history of quality circle application in Japan's construction industry will be described using Japanese sources. Considering the differences that exist between manufacturing and construction industries, and noting the huge cultural and social differences between Japanese and Western workers, it is not difficult to understand the United States construction managers' reluctance to implement quality circles.

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Note.—Discussion open until February 1, 1988. To extend the closing date one month, a written request must be filed with the ASCE Manager of Journals. The manuscript for this paper was submitted for review and possible publication on August 1, 1986. This paper is part of the *Journal of Construction Engineering and Management*, Vol. 113, No. 3, September, 1987. ©ASCE, ISSN 0733-9364/87/0003-0427/$01.00. Paper No. 21795.

The main contribution of this paper is the presentation of suggested guidelines for implementing quality circles in a United States construction company. These suggestions are based on the considerable amount of research described in available publications and direct interviews with a few United States companies that are now using QC successfully. It is concluded that if used effectively, QC principles can work in the construction industry and can improve productivity, quality, and labor motivation.

History

The history of Quality Circles dates back to the early 1950s in Japan. Many factors are responsible for the evolution of total quality control (TQC) and quality circles. Lack of Japan's natural resources left the country no other option than to become highly competitive in the international export market. Also, Americans who administered Japan after World War II felt compelled to put Japanese industry on its financial feet as quickly as possible. Japan's manufactured products were generally of poor quality and could not compete in international markets with Western counterparts. The only way to make Japanese products more competitive was to improve their quality.

In response to these concerns, a number of American industrial experts were invited to Japan. Seminars were taught by such authorities on management and economy as Edward Deming, J. M. Juran, Douglas McGregor, Fredrick Herzberg, and others. These experts were responsible for introducing statistical quality control concepts to Japanese managers. Total quality control (TQC) was also proposed by Juran. TQC was developed upon the principle that in order to provide genuine effectiveness, control must start with the design of the product and end only when the product has been placed in the hands of a customer who remains satisfied.

Japanese industry was very receptive to these new ideas. This quality concern soon became part of the Japanese culture because of its basic values of total participation and loyalty.

In the early 1960s, Kaoru Ishikawa, president of the Musashi Institute of Technology of Tokyo, helped organize quality circles in Japan (Gilly 1986, Ishikawa 1985). He worked closely with the Japanese Union of Scientists and Engineers (JUSE) in developing training material for the circles. Ishikawa defines quality circles as follows: "The quality control circle is a small group to perform quality control activities voluntarily within the same workshop. This small group carries on continuously as a part of company-wide quality control activities, self-development and mutual development control and improvement within the workshop utilizing quality control techniques with all the members participating" (Ishikawa 1985). Quality circles spread among Japanese companies very quickly. The promising consequences of utilizing this concept encouraged management to increase the number of circles exponentially. Soon several thoroughly polished sets of training material and courses on quality circles methods were published. In 1962, a magazine called "The Foremen and Quality Circles" started to appear quarterly. It is now a monthly

publication. It is written simply and clearly, and priced attractively to allow supervisors and workers to buy it.

Circle Structure and Implementation

A circle is made up of a group of people, usually five to 15, who work together. This group can be carpenters, workers on an assembly line, or a group of people working in an office. Members of the circle meet together voluntarily, usually for one hour a week, to identify, isolate, discuss, and solve problems that keep their company from being more productive. Many quality circles have the following structure: (1) Steering committee; (2) circle coordinator; (3) circle facilitator; (4) circle leader; and (5) circle members.

The steering committee is usually an advisory and policy-making group composed of the managers in the fields of quality, production, and personnel. They support and monitor the circles in the company, provide guidelines, and exchange information and knowledge pertinent to the use of the concept and methodology of quality circles.

The circle coordinator supervises facilitators and directs administration of the circles' program. His role is sometimes initially played by a consultant and taken over later by the facilitator. For this reason, in many companies there is no coordinator for the circles' program.

The circle facilitator supports the circle in several ways. The facilitator provides a liaison to management, chooses the problems the circles can work on, or locates the experts and brings them to the circle meetings. The circle leader is usually, but not always, the first line supervisor of the work unit within which the circle is located. The leader manages the circle meetings, paying particular attention to the members' participation and the careful execution of each step in the problem-solving process. The circle members are the most important part of the circle. They participate in circle meetings, identify and analyze problems, collect data, determine and implement solutions and prepare management presentations. The noncircle members and management are kept informed of the circle projects and are given the opportunity to contribute ideas at various stages of problem solving.

Before the circle starts working, the members are trained. Training can be conducted by in-house people or by outside consultants. Generally, facilitators and leaders undergo a three to four day initial training period. Then the facilitators and leaders transfer the lessons to the circle members. These lessons are usually taught using problem-solving techniques as the circle members go through an actual problem in their work area. Members also learn to present their conclusions and recommendations to management. Management can, of course, reject, modify, or accept the circle's recommendations (Barra 1983). All the while, the members are learning about their jobs, their sections, and their plant. They experience personal growth and development, and learn to communicate with each other, their supervisor, and their management.

Quality circles were first implemented in manufacturing environments, but later the concept was implemented in other industries such as construction. Generally, the program's success requires careful planning and a serious commitment on the part of management. The pro-

gram should have continuity. It is not to be used for a while and then abandoned. A number of experts emphasize that circle activity participation should be on a voluntary basis. At the same time, it is very important that all the members of a circle should contribute to the circle regularly.

Quality circles provide a sense of cooperation and participation among the employees. Its effect on morale and motivation cannot be denied (Juran 1980, Ishikawa 1985). Through circle activities, a worker is allowed to recommend important decisions that affect him. Through problem solving, the workers will become more concerned about the company's problems and motivated to obtain a higher decision-making power. Quality circles are a means for allowing workers a sense of dignity, a sense of fuller participation in the organization, and an opportunity to develop and advance their skills. J. M. Juran (1980), one of the pioneers of TQC, believes that an effort to launch a quality circle movement might receive more acceptance by management on the grounds of improving morals than quality.

Construction Industry Characteristics

As has been mentioned earlier, the QC concept evolved in manufacturing industries. Manufacturing industries are different from the construction industry in many respects. The following list includes a few important characteristics that distinguish construction from other industries:

Uniqueness of Every Project.—Each construction project is unique, built in varying locations under varying conditions and by a workforce that is constantly changing (Araki 1984, Gilly 1986).

Variable Workforce.—The large majority of United States construction companies do not keep a constant work force. Hiring employees only when required for a job seems to adversely affect employees' training and commitment as required in the QC concept. However, this is not the case in Japan's construction industry. This issue will be discussed later.

Duration.—Since each project is unique, its duration will also be unique. Also, generally, the time required to achieve a goal in construction is considerably longer than the time required in other industries.

Subcontractors.—In all major construction projects, a number of subcontractors are working for the general contractor. In this country, the general contractor has little control over subcontractors' personnel; consequently, even if the main contractor intends to organize circles, it might not be successful with the subcontractors' laborers. In Japan this problem is not an important obstacle because, generally, large construction companies keep working with the same subcontractors project after project. Long-term planning is more feasible under such conditions.

Owner Influence.—The continuous participation of the owner in projects is another peculiar characteristic of the construction industry. Most of the time the owner directly influences the production through changes in design and specifications which, in turn, will change the completion date. In other industries, the owner usually does not influence the production.

Hierarchical Organization.—Generally, construction companies have short organization charts, i.e., there are relatively few hierarchical levels between the lowest and highest persons in the company (Parker 1980). This will allow for a quicker reaction and adjustment to changes; however, it will require higher communication skills from management.

These have been a few important differences that exist between construction and manufacturing industries. Some of these factors, especially uniqueness of each project and the variability of work force and subcontractors seems to be obstacles to implementing quality control (QC) in construction. These factors, and especially the first two, have caused the lack of interest and enthusiasm on the part of U.S. construction managers towards quality circle programs. However, Japanese construction companies have been using Quality Circle for at least 10 years now. Let us examine the Quality Circle implementation in Japan's construction industry.

Quality Circles in Japan's Construction Industry

Use of the QC concept did not start in Japanese construction companies until the mid-seventies. This was because people in construction industry were skeptical about QC success in construction due to the abovenamed differences between the construction and manufacturing industries. The 1973 oil embargo and the steep increase in oil prices adversely affected the prospects of future construction contracts in Japan. Construction companies started thinking about methods for reducing the cost of the operations. In other words, the decrease of potential work quantity stimulated a drive to decrease the cost while keeping the quality levels as high as possible. Thus the "oil shock" of 1973 was one of the main reasons for the initiation of QC programs in construction. Total quality control (TQC) was first introduced in construction by Takenaka Komuten Company, which is number six in Japan and number 16 in the world from a contract volume point of view, [Engineering News Record (ENR) 1985]. The disastrous collapse of a sheet piling system, in 1975 in Okinawa, Japan, shook the company. It had been well known for its safety and quality standards. This accident, and the oil embargo, caused Takenaka Komuten to try a QC program (1975). Shimizu Construction Company, which is number two in Japan, number seven in the world (ENR 1985), and Kajima Corporation, which is number three in Japan, and number ten in the world (ENR 1985), started QC programs in 1976 and 1978, respectively. At this time, almost all large construction companies are using QC concepts.

In order to implement quality circles in construction, cooperation of subcontractors is needed. Large companies work with several subcontractors in any sizeable project. Usually, a meeting is held at the head office of the main contractor. Here the significance of QC programs are explained to executives of the subcontracting companies. When the project starts, a few foremen are selected to be trained as circle leaders. They are invited to attend circle meetings held by the main contractor and to watch other circle's presentations. After this, the circle leaders will form their circles. Each circle is composed of a few workers (less than ten) that are working in the same area and doing the same thing (e.g., truck

drivers or cement masons). At the QC meetings, engineers and representatives of site managers with previous experience in quality circles help the circle members with advice, recommendations, and evaluation of their performance. As the project progresses, the number of circles is increased, and most of the project activities will be covered by QC programs. Larger meetings are held occasionally, and the successful circles and members are praised and rewarded. Awards are usually not monetary. Often the names of successful members are printed in company publications.

Unfortunately, good reporting systems within construction companies to accurately quantify the benefits of applying QC programs have been lacking. However, there are reports of production increase or cost decrease on a case-by-case basis. Also, there are many indications that QC programs are effective in improving labor motivation and morale. Here are a few examples of cost saving or production increase resulting from QC programs. They have been selected from numerous cases available.

1. In a nuclear power plant project under construction by Taisei Corporation, it was found that operating costs of construction equipment was 12.8% higher than estimated. Using quality control circles techniques, the problems were pinpointed and solved, causing a 15% reduction in cost (Taisei Monthly Magazine 1986).
2. On a highway project under construction by Taisei Corporation, it was found that the loss rate of ready-mixed concrete was too high. A quality circle composed of cement masons found out that the most important reason for this was due to an inaccurate checking method. By applying the circle's recommendations, the loss rate was reduced by 11.4% (Taisei Monthly Magazine 1986).
3. In a building project by Shimizu Construction Company, many cases of faulty reinforced concrete work were reported. The iron workers quality circle examined their work thoroughly and soon the faulty workmanship disappeared. A 10% increase in productivity was also achieved [Foreman Quality Control (FQC) Journal 1981].

Despite some adverse characteristics of the construction industry, Japanese contractors are using QC extensively and successfully. As T. Yamada, administrator of TQC processing committee of Takenaka Komuten Company, puts it, "Although the construction industry has many unique features that are not desirable for TQC application, it does have some good features for that purpose too. For example, a carpenter takes a certain pride in what he is building. Improving the quality of his workmanship is very stimulating to him and QC can help him achieve this quality improvement" (FQC Journal 1981).

Quality Circles and United States Construction Industry

It has been much less than ten years since some of the United States construction companies have also started to use this concept. Generally speaking, the QC concept has been much more successful in Japan than in western countries like the United States. There are vast cultural and social differences between Japan and the West; QC programs will be

affected by the society and culture within which they are implemented. A detailed discussion of these cultural differences is given in Levitan and Johnson (1983), Ishikawa (1985), and Gilly (1986). Ishikawa (1985) counts 14 major differences in society, labor attitudes, government role, management philosophies, pay system, labor turnover rate, etc., between Japan and the Western world. In short, the labor-management relationship in the Western world seems to be less friendly, less loyal, and based on monetary gains. The characteristics of the construction industry, especially in the United States, have created an attitude that is unreceptive to the idea of participative management. Construction is the single largest employer in the United States, historically contributing more than 10% of the gross national product (GNP). Productivity rates in construction have declined sharply during the past 15 years (Stokes 1980, Hayes and Aberthany 1980). The reasons for this decline are numerous (Borcherding 1976, Maloney 1978).

It seems that the QC concept, whose main objectives are improving motivation, productivity, and quality, should be tried in the United States construction industry. However, the number of alternate elements and personnel, the uniqueness of product, the undefined scope of the project, and the variability of work force have made many construction managers believe that quality circles cannot be applied to construction. Another reason for industry's resistance to QC seems to be the management's reluctance to make changes (Herring 1983). Managers fear losing productivity while the QC implementation goes on (Ishikawa 1985). Construction managers in the United States tend towards an authoritarian management approach (Borcherding 1977). This approach is losing its effectiveness because labor is now far less dependent on the employer (Parker 1980). What labor needs, apart from job security, is job satisfaction and self-fulfillment (Maslow 1954, McGregor 1960).

Case Studies and Recommendations

Many large companies in the United States have been contacted by letter or telephone on the QC issue. The names of the companies who were not using, or not even considering using QC, make up a long list. Some companies, like Bechtel, are planning to introduce some sort of participative management into their current system. In 1986, Bechtel will be offering "The Productivity Management Process Program," a series of modules designed to ensure that managers and supervisors develop the skills required to improve productivity. The program's objectives are to move the organization to a more participative style of management, and to encourage employee innovation, involvement, and group problem solving.

A few companies are actively using quality circles. Some of these companies have been questioned by letter, interviewed by telephone, or sometimes both. The following companies have been considered in this study: (1) Brown & Root, Incorporated; (2) Hawaiian Dredging; (3) J. A. Jones Construction Company; and (4) Phelps, Incorporated.

A condensed format of the essential information gained from interviewing these companies is given in Table 1. By reviewing the relevant technical literature and interviewing knowledgeable persons in construc-

TABLE 1.—Summary of Results

Company (1)	Year of implementation (2)	Did they introduce concept when starting project? (3)	Did they start with a pilot project? (4)	Do they involve unions? (5)	Do they have a gain-sharing program? (6)	Are their circles task related? (7)	Do they keep a progress report? (8)	Observation (9)	Results (10)	Type of project (11)
Brown & Root, Incorporated	1982	Yes	Yes	No comment about it	Yes	Yes	No, but similar technique	Although this company has had good results with circles implementation; due to the low prices of oil, they do not have the opportunity to expand the circles concept to the rest of the company now. However, they hope to do it later on.	"A gain of $850,000 the last 2 years"	Petrochemical
Hawaiian Dredging	1979	Yes	Yes	Information not available	Yes	Yes	No	They made a complete modification of the format. The current program is called involvement teams. It teaches middle management leadership and participatory problem solving techniques.	"We have had some success with quality circles."	Repetitive task construction.
J. A. Jones Construction Company	1980	Information not available	Yes	Yes	Yes	Depending on the type of jobs	Yes	The implementation of construction quality circles takes place on roughly three levels as determined by the total number of craftsmen in the largest craft.	"Crew information with circles exceeds company norms"	Repetitive high-rise building
Phelps, Incorporated	1983	No	Yes	Yes	No	Yes	NA	The program is called volunteers improving performance (VIP). In September 1984, they had 28 active VIP quality circles.	"The program has been successful"	Building and Industrial

J. Constr. Eng. Manage., 1987, 113(3): 427-439

tion companies, the writers believe that for successful implementation of QC in a construction company, the following issues should be carefully considered:

1. Start the QC implementation with a new project and small, easily solvable problems. Most of the time, the nature of construction problems are more complex and less-well-defined than manufacturing problems. It is a good idea to start QC implementation with a new project and to resume the circle's activities by addressing specific, simple, and relatively easy-to-solve problems. The program should never start on an already troubled project. Research has shown that when foremen or superintendents were the busiest and under the greatest pressure, they were the most reluctant to try a new method, even though it was obviously one that would save money or effort in the long run (Parker and Oglesby 1972).

Almost all of the companies interviewed started implementing the concept with a pilot project. The pilot project allows companies to perceive the employee's acceptance of the concept and to help him make modifications for future project-wide implementation.

Scott Conrad, director of the voluntary improving performance (VIP) program (quality circles program at Phelps, Incorporated) advocates starting with short-term, simple problems for QC implementation. This approach has worked well at Phelps, Incorporated (Conrad, 1985).

2. Consider the workforce stability in forming a circle. Most of the United States construction industries' workforce is temporary. Labor is hired for a specific project and moves on to other projects after the job is completed. Some laborers, however, have been working with a single company for a relatively long time. Actually, a study of Operating Engineers Local No. 3 in 1969 showed that 49% of the union members had worked longer than two years for their present employers, and 20% had worked more than five years (Parker and Oglesby 1972).

It seems to be a good idea to start forming quality circles among these more stable laborers. This has proven very successful in the case of Phelps Incorporated. Otherwise, too much effort is expended training people who will soon leave the company. This migratory nature of construction labor is one of the major obstacles of implementing QC programs.

3. Establish a recognition system or gain sharing program. Recognition is important to the success of quality circles. According to the Japanese cultural values, recognition of an employees' contribution is the best reward. Appearing in a company newspaper or on a bulletin board can contribute positively to the Japanese workers' motivation. It seems that in the West, tangible rewards are necessary as well as recognition. The main purpose of this program would be to reward the active, successful circle member. Although this reward system can be motivating and increase the productivity at the early stages, it is believed that a monetary reward can become a demotivator (Herzbert 1968). Instead of motivating the workers to work efficiently, it motivates them to keep looking for another reward. Generally, awards should be small gifts, newspaper articles, annual dinners, or even paid vacations. As one personnel manager from Brown & Root Incorporated puts it, "We have a corporate guideline for rewards which uses all the way from letters of

recognition to trips to the Company lake. But we do not use monetary rewards."

The Phelps VIP program prints a newsletter that reports on the circles' activities on different job sites and mentions the names of the successful circles, individuals, and their achievements during each month.

4. Circle members should be task-related. Circles can be organized by department, by task, or by issue. A task-common circle is a circle whose members have the same daily task. For example, a group of carpenters working on concrete formwork can form a task-related circle. On the other hand, an issue-related circle is one whose members are interested in a common issue, e.g., a circle formed by workers from different departments that are interested in achieving higher work quality. Due to the construction projects' complexity, the quality circles should be task-common; the scope of members' responsibilities, in respect to the circle, should be as specific and as narrow as possible. According to a manager at J. A. Jones Construction Company, "The essence of the character of a circle in construction is that its members are task-common" (Jones and Kratt 1983).

Scott Conrad (1985) of Phelps, Incorporated shares the same viewpoint, "One of the keys to success was a common interest toward the completion of a common task (i.e., carpenters and carpenter helpers working on foundation wall formwork). Groups comprised of a wide variety of craftspeople were effective in addressing general concerns such as safety, but did not share comon interests when discussing task related problems."

5. Involve the foremen in QC activities. Traditionally a foreman in the construction industry is a person who, often with limited education, has taught himself the technical aspects of the business. Suppose, as a foreman, you were told to start quality circles in your area to allow workers a chance to solve their problems. Is it not your job to solve their problems? What if your people recommend changes to eliminate a problem that you never were aware of?

It would be difficult for first line supervisors or foremen to switch to a participative management style overnight. Great care should be taken in handling this situation. Foremen should be involved in all training sessions. Most of the time, they are the most suitable candidates for circle leaders; in Japan, the foremen are usually circle leaders. In a letter to the first writer, the training and quality development manager of Hawaiian Dredging explains how his company has involved foremen and middle management in QC programs, "Our current program is called involvement teams. The emphasis in this program is directed to training of the project superintendent, project engineer, and craft foremen in leadership and participatory problem solving techniques."

6. Involve Unions in QC activities. Involvement of union in QC is a delicate matter. The Japanese construction industry is not confronted with this issue; this facilitates QC implementation in Japan. A great percentage of the United States construction workforce is unionized. It seems that without involving union labor, the success of a QC program would be very doubtful. Different companies interviewed have involved the labor unions in their QC programs. Understanding and cooperation between management and the union is crucial. Managers should not use

quality circles as a way to decrease union influence. This would lead to distrust on the side of unions and the probable failure of the QC program. One method of involving unions would be to conduct one or more off-site, union-management workshops in which participants explore the union-management relationship through group processes. These off-site workshops can clarify the circle concept and define the role of a union-management steering committee (Greenwood 1983).

7. Measure and quantify the effect of the QC program. The most effective way to convince a company's top management to truly support the QC program is to show the tangible gains resulting from QC implementation. As mentioned previously, there appears to be no published data about the amount of savings resulting from implementation of QC in Japanese construction companies. In the United States as well, companies cannot exactly quantify the savings that resulted from the QC program; however, some informational or irregular reports do exist. For example, Brown & Root Incorporated has informal reports in which they keep track of the monetary gains or losses of QC. A well-prepared report in this respect can also be useful in identifying successful workers and circles. With such reports, workers are informed of their work improvement and the effectiveness of the QC program.

The above issues, in the authors' belief, are all important in a successful implementation of a QC program. Obviously, these can be modified under different circumstances, so they should be used as general guidelines only.

Benefits of QC Program

QC programs have been beneficial to manufacturing industries in at least three important respects: (1) Productivity; (2) quality; and (3) motivation. Most probably, QC can affect the construction industry in the same ways as well. Factors contributing to productivity are numerous (Sutermeister 1976); however, one of the most important factors in construction productivity is the effect of communication (Parker, Oglesby 1972; Parker 1980). "Construction productivity is directly related to the amount and quality of the communication that flows between the people who are managing, and those who are doing the work" (Parker 1980). A QC program, if managed efficiently, would no doubt increase the communication level between different parties involved in a project. This in turn increases production. In one Phelps project, according to the VIP September 1984 report, the QC team working on the cover-box assembly crew recommended methods to increase production in their area by an estimated 38%. Upon implementation of their assembly line suggestion, this crew was able to achieve production increases up to 52% over previous means.

The QC program would have the same effect on quality also. In Japan, QC is part of the total quality control (TQC) concept that is responsible for the control of quality in every aspect of company activities. Participating in circle meetings, trying to find ways to improve production and solve problems, and suggesting methods to facilitate the work flow and process should enhance the quality.

Motivation is another factor that affects productivity. Motivation of construction workers and its effects have been examined by many researchers (Schrader 1972, Maloney 1981). All show the great potential for increasing production by improving labor morale and motivation. If Maslow's hierarchy of need model is examined for construction workers, it seems that the worker is not motivated by the basic needs of life such as food and shelter (Maslow 1954). His job is also relatively secure because of union agreements. What motivates labor is more the need for self-esteem. Quality circles provide a means by which labor can participate in making the decisions that affect their jobs. Through problem solving, employees will become more concerned about the company's problems and motivated to obtain a higher decision-making power.

Summary

In this paper, the evolution of the quality circle program in Japan and the basic components of a circle have been briefly described. The existing differences between manufacturing industries and construction has been explained, and a brief history of QC implementation in Japan's construction firms has been given using Japanese sources and literature. United States construction industry characteristics have been examined and compared with Japanese construction firms. It is believed that due to the uniqueness of each construction project, variability of the workforce, and the undefined scope of the job, it would be difficult to implement classical QC concepts in the construction industry. However, it is possible to increase the chance of success of QC in construction by modifying some of the classical aspects of QC and following the recommendations below: (1) Introduce the QC concept at the beginning of a new project; (2) choose small, easy problems to start the circles' activities; (3) start with a pilot project; (4) start the program with the more-stable work force; (5) establish a recognition system or a gain-sharing program; (6) involve the foremen and lower-level management in the program; (7) involve the labor unions; and (8) establish a reporting system to quantify the gains and losses resulting from the QC program.

In the writers belief, and according to the United States companies that are already using QC programs, if implemented carefully, QC can improve labor motivation, productivity, and work quality.

Appendix.—References

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