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Quality Assurance in the USA and Japan: a Comparison

Assurance de la qualité aux Etats-Unis et au Japon: une comparaison

Qualitätssicherung im Bauwesen der USA und Japan: Ein Vergleich

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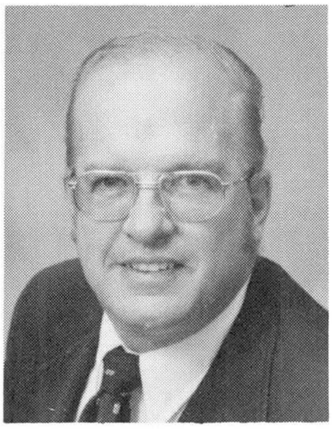

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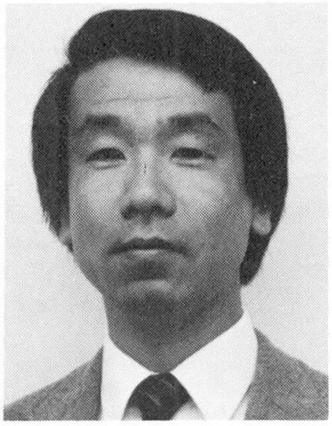

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SUMMARY
This paper begins by defining some of the common concepts related to quality. It then points out the differences between the construction industry environment in the United States and Japan. Research results related to a «Case Study» building construction project illustrate how these differences would influence quality related practices if the same project were built in each country.

RÉSUMÉ
Cette présentation définit quelques concepts communs en rapport avec la qualité. Elle souligne les différences entre l'environnement industriel de la construction aux Etats-Unis et au Japon. Le résultat de ces recherches dans le cas précis d'un projet de construction de bâtiment montre les différences et l'influence des pratiques concernant la qualité, si le même projet devait être exécuté dans les deux pays.

ZUSAMMENFASSUNG
Der Beitrag definiert zunächst einige allgemeine Begriffe aus dem Bereich der Qualitätssicherung. Danach weist er auf die Unterschiede in den Existenzbedingungen der Bauindustrie in den USA und Japan hin. Die am Beispiel eines konkreten Bauobjekts gewonnenen Forschungsergebnisse zeigen, wie diese Unterschiede beim gleichen Bauobjekt die qualitätsorientierten Praktiken in den zwei Ländern beeinflussen würden.

1. INTRODUCTION

1.1 Differing Practices

Achieving and maintaining an owner's satisfaction with the quality of a building during the life cycle phases of design, construction and operation must be one of the primary goals of the construction industry in any country. The specific practices which are adopted to meet that goal will probably differ from country to country because practices are, to a certain extent, culturally dependent. Historical patterns which have developed as the engineering and construction communities have matured and owners have responded to that maturation set the boundaries for local present day practices.

1.2 Common Concepts

It should be recognized, however, that certain fundamental concepts related to quality transcede such constraints and have resulted in some universal commonality. Concepts such as those below are examples [5].

Quality - Fitness for Use - The extent to which the product successfully serves the purposes of the user, during usage, is called 'fitness for use'.

Quality of Design - Quality of design can be regarded as a composite of three separate steps: (1) identification of what constitutes fitness for use to the user, (2) choice of a product or service concept which is responsive to the identified needs of the user, and (3) translation of the chosen product concept into a detailed set of specifications and drawings.

Quality of Conformance - Once the quality of design has been specified, the quality of conformance is expressed as the extent to which the product conforms to the quality of design.

Quality Control - Quality control is defined as the regulatory process through which the actual quality performance is measured and compared with standards, and the resulting actions which are taken to correct the differences which are uncovered.

Quality Assurance - Quality assurance provides the evidence needed to establish confidence that the quality function is being performed adequately. Typically the producer not only produces the product but also prepares and makes available to the customer the proof that the product is fit for use.

Quality of Maintainability - Quality of maintainability consists of two aspects: (1) preventative or scheduled maintenance consisting of tests and checkouts to detect potential failures, and (2) unscheduled maintenance consisting of restoring service in the event of failure.

1.3 United States and Japan

An examination of the construction industries in the United States and Japan indicates remarkedly different environments. Research literature indicates that the construction industry in the United States is widely acknowledged to be dispute prone. In the traditional 3-party mode, the Owner, Architect/ Engineer and General Contractor are brought together under fairly explicit contractual arrangements on a project by project basis. Each party often attempts to maximize its own short term goals at the expense of the other parties involved.

Under such a situation, when cost, schedule, quality and safety are among the multiple objectives, the one that can easily be sacrificed if special precautions are not taken is quality. Adding to the complexity of the situation is the orientation of the individual craftsmen on the construction project. Their loyalty, particularly in situations where the work is being performed in a "union" environment, is not with the contractor, it is with their local union hiring hall. They are often temporary employees of a particular contractor, who under the best of conditions, may only be employed by the contractor for the duration of the project. Long range training with regard to the contractor's quality philosophy and practices is difficult under these conditions.

The situation which exists in Japan appears to be markedly different. It has been characterized by parameters such as:

Life-time Employment - Japanese enterprises hire their employees directly after graduation from school and employment generally extends over the entire working life of the employee. They do not expect new employees to obtain special skills while they are students, rather they are willing to provide any training that is necessary for the specific jobs assigned to the employees throughout their employment.

Ranking by Seniority - It has been a tradition of the Japanese society to respect those who are older. It is generally agreed that ability (and contributions) in the company increase with length of service. Under seniority management, even a very able employee cannot be promoted without the adequate number of years of service required to achieve status in the organization.

Long-Range Company Strategy - Life-time employment and seniority are reflected in the long-range perspective of company strategy. Enterprises are judged in terms of long-range rather than short-range success factors. Therefore, firms spend a great deal of money for research.

High Group Spirit of the Work Force - Japanese workers tend to have high self-esteem. Job security is one reason and high group spirit is another. An emphasis on group activities while they are students teaches them to be sensitive to peers and restrain from personal egotism.

Contractual Relationships - It appears that in Japan, construction documents are not necessarily expected to contain nor exert requirements which constrain construction project practices and the interactions of the parties involved. What is most important in Japan is that the parties maintain an amicable relationship. The Japanese tend to settle their differences by negotiation rather than by litigation. In addition, although the legal relationship between an owner and the contractor appears to be equal, the owner traditionally assumes the dominant position. His satisfaction is often the key determining objective when project decisions are made.

2. CASE STUDY

2.1 Comparative Analysis Procedure

Given the above differences it was felt that a comparative analysis of the quality related practices in the two countries would be of interest. Ideally, such an analysis should be performed by individuals who had worked within the construction industry in one of the countries and were then given the opportunity to observe, for an extended period of time, the practices in the other country with an unbiased perspective. The opportunity to implement the beginning phases of such a research project design was created by the presence of Taka Konishi, an experienced construction engineer with the Shimizu Construction Company, in the graduate program in Construction Engineering and Management at The Pennsylvania State University. In order to provide fundamental data for the early stages of the research it was deemed appropriate to assign Mr. Konishi, who at the time, was totally unfamiliar with the construction practices in the United States, to only one project, a $3 million Academic Activities Building located on the University Campus. After his data was collected he was requested to also develop a hypothetical model of how the Shimizu Construction Company, one of Japan's major design/construction firms, would have approached the construction phase of a similar type building if it were built in Japan.

2.2 Case Study Description

Observations were made on the construction site during the period from June to September 1984. The project site consisted of approximately two acres, located on the northeastern portion of the campus. The approximate total area of the building is 50,000 square feet. The structure consists of concrete masonry unit bearing walls with open web steel joists spanned with a steel roof deck and poured floor slabs. The Owner retained an Architect/Engineer who first prepared the plans and specifications and then exercised some degree of inspection, monitoring and controlling during the construction phase. The Owner coordinated the work of separate lump-sum/fixed-price contracts for the (1) general, (2) plumbing, heating, ventilation and air-conditioning, (3) electrical and (4) library equipment work phases. Primary observations were related to the practices of the construction firm that held the general construction contract.

2.3 Case Study Observations

The case study revealed several areas of unsatisfactory performance. These can be summarized as follows:

2.3.1 Quality of Design

A number of mistakes were found on the drawings. This was probably caused by an inadequate formal review system during the design phase. Insufficient coordination of general, structural, mechanical and electrical design occurred because of a lack of specialized staff in these areas in the A/E firm. In addition, over specification occurred in a number of instances and there were difficulties associated with the A/E firm's interpretation of the specifications, perhaps because the structural, mechanical and electric consulting firms that had performed the designs did not have direct contact with either the Owner or the individual Contractors.

2.3.2 Quality of Conformance

The quality of conformance, relied, for the most part, on the abilities of the general contractor's superintendent. As far as the case study is concerned, the superintendent's responsibilities covered almost all items except the very specific technical ones associated with electrical or mechanical work. It is the opinion of the writers that the superintendent did not have sufficient support staff. He carried too much responsibility and was not, therefore, able to implement all of his duties satisfatorally. As a result, although the superintendent had extensive experience in field construction and a relatively good attitude towards the quality of construction, a number of deficient, corner cutting practices were observed. He often placed an uneven emphasis on the quality of the work.

The symptoms of this situation were:

- No updated schedule was used as a framework for controlling the project.
- Little effort was placed on the review of shop drawings. A structural shop drawing, which defined precise building dimensions, was not prepared.

- There was not enough attention paid to the protection of the installed project or stored material from damage.
- No formal quality related educational program to provide motivation of the worker was observed. No formal daily meetings to allow good communication among those involved on the project site were identified.

In addition, within the total project organization on the site, there was no formal procedure for establishing QC/QA tasks and functions and delegating QC/QA responsibility and authority. The respective responsibilities and authority among the A/E, the owner and the contractor were never satisfactorily clarified.

2.3.3 Feedback and Feed-Forward Information System
No satisfactory feedback and feed-forward information system was observed. This is because there was no incentive for each party to establish comprehensive visibility of his work for other parties and because each party tended to protect himself by performing only his work responsibilities, instead of cooperating and prompting open discussion of quality problems. As a result, no formal documentation system of inspection and daily supervision procedures were established. Also no formal feedback system to prevent recurring mistakes on future projects were initiated.

3. JAPANESE ALTERNATIVE

3.1 Total Quality Control Systems

Large Japanese construction firms such as the Shimizu Construction Company have introduced Total Quality Control (TQC) systems in order to improve the QC/QA procedures on building construction projects, as well as throughout the overall company organization. The main purpose of TQC is to secure the satisfactory quality of the project as well as accomplish company-wide cost effectiveness through the implementation of the work. The TQC system of the Shimizu Construction Company has the following four characteristics: (1) the TQC process begins by establishing both the social and individual market needs and ends with a final evaluation by the customers. (2) the TQC system is supported by well-organized documentation to allow each person to visualize his own work assignments and decision-making responsibilities; (3) the TQC is reinforced by quality training, QC circles and the standardization of manuals; and (4) the TQ system is supported by an informational system which utilizes a computerized system to deal with accumulating and developing the feedback information.

The Quality Assurance system, which forms the main framework of the TQC system, is divided into six components. (In the listing below, only a few of the components are defined in detail).

1. Development and Improvement of Technology
2. Design Phase
3. Construction Phase: For the purpose of integrating the overall capability of Shimizu, an "Overall Construction Plan" is developed which describes the entire construction phase and the utilization that will be made of other staff functions. During construction, Quality Control Process Charts, (which divide the work responsibilities and clarify and utilize job sequences) are executed. These activities are monitored and evaluated by pre-construction, intermediate, and construction review conferences, as well as through a final inspection.
4. Maintenance Phase

5. Resolution Activities for Important Quality Problems: In order to prevent the common quality failure in buildings, company-wide research studies and conferences are initiated. The findings from these activities are standardized and published in the supplementary specifications.

6. QC/QA Information System: For the purpose of supporting the development of new technology and preventing recurring mistakes or accidents, the SQIT (Shimizu Quality Information Table) system has been designed as a company-wide QC/QA informational system.

3.2 TQC Application to the Case Study

When the above TQC system requirements were overlayed on the Case Study project, by assuming that the Shimizu Construction Company would build a similar type of project in Japan, it was hypothesized that the following approaches would have been taken:

1. More site engineers would have been assigned (approximately 3 site engineers vs. one superintendent in the case-study) to the project in order to complete it in a shorter time period. In addition, the site office would have been supported by a special staff (mechanical and electrical installation, construction technology, estimation, procurement, cost control, safety and administrative departments) from the main office.

2. A review of the design drawings and documents would have been made by each special staff function, as well as by the project manager and the site engineers. The result of all of these reviews would have been compiled into a "proposal of improvement in design" which would have been submitted to the owner and architect/engineer. Such a proposal would represent the start of a feedback, feed-forward system of communication between all parties involved.

3. An "Overall Construction Plan" would have been prepared by the project manager based upon the design drawings and documents as well as upon upper management policies.

4. A "pre-construction conference" would have been held for all supporting staff as well as the project engineers', in order to verify the "overall construction plan" and to examine the information and know-how which each function possessed.

5. An overall construction schedule divided into quality control, cost control, schedule control and safety control would have been developed. This schedule would then be monitored by the project office and supporting staff who would also make periodic inspections. An "intermediate-construction conference" would also have been held to verify the execution of construction before beginning the work.

6. A "final inspection" and "construction review conference" which would summarize the results of feedback information and know-how in each function would have been held.

7. Daily site office meetings would have been established to assure that all site engineers and foremen involved with site construction received a consensus of the daily and weekly arrangements of work.

8. Morning assemblies would be held daily for all site staff and workers before daily work began.

9. More effort would be devoted to the earth and structural phases. Extensive effort would be expended by the site engineers towards developing shop drawings, related to structural and construction methods

in these phases. The structural shop drawings would become the basis for all other shop drawings.

10. "QC Circles" would be established in order to foster the improvement of the quality of both the end product as well as the process.

4. RECOMMENDATIONS

Although the above research effort only represents the beginning stages of a comparative analysis of contractor Quality Control/Quality Assurance procedures in building construction projects, several interesting recommendations can be made. The impact of these recommendations and the feasibility of implementing them in the United States will of course have to be studied in greater detail.

4.1 Increased Engineering Effort on Project Sites: It appears that more field engineers and support staff are assigned to projects in Japan. It is felt that construction projects in the United States could also benefit from such a staffing strategy. The development of shop drawings as well as construction planning and scheduling is essential for the successful completion of a construction project. Field engineers could assist in such efforts. They could, for instance, review the design to prevent the mistakes of the design phase from being executed by the work force. If field engineers do not assume that any preceding work (i.e., design) is done perfectly, there will be greater cost effectiveness in the whole construction process. It is felt that a single superintendent on a project is physically not able to carry out all of these tasks by himself.

4.2 Good Inter-relationships Between Parties: There seems to be compartmentalization between the Architect/Engineer and the Contractor. The contractor feels that the Arhitect/Engineer has built the structure on paper and it is his responsibility to build in the field. The contractor does not invite any "interference" from the A/E because he feels that the A/E is too theoretical and that he (the contractor) knows more about field related aspects. As a result, this tends to discourage the improvement of QC/QA procedures in construction. The cost effectiveness of cooperation in the construction process to all parties should be emphasized. A more inter-related organizational system must be maintained so that each party can review the other's work in order to prevent mistakes and promote improvement in the quality of construction.

4.3 Training and Motivation: The awareness of the people involved in the construction project in most significant. No matter how well established the QC/QA system is, it will not work if those involved do not know how to operate it. Therefore, educational systems which correspond to the various levels of people involved in the project should be established. It should be emphasized that the conventional misinterpretation of QC/QA procedures must be changed. QC/QA procedures in the construction industry in the United States have generally been limited to testing and inspection. There was little consideration given to the fact that "quality is produced through process". Rather, it was felt that good quality was obtained by rejecting bad results. However, this should not be the final objective of QC/QA procedures in building construction. This concept can be fostered by means of sufficient quality related training and motivation.

REFERENCES

1. ABDUN-NUR, E. A., Product Control and Incentives, Journal of the Construction Division, ASCE, Vol. 92, No. CO3, Sept. 1966.

2. AMERICAN INSTITUTE OF ARCHITECTS, AIA Document A201 General Conditions of the Contract for Construction, 1976.

3. BUSINESS ROUNDTABLE, Modern Management Systems, Report A-6, Construction Industry Cost Effectiveness Project, Nov. 1982.

4. FEIGENBAUM, A. V., Total Quality Control, McGraw-Hill, 1983.

5. JURAN, J. M., Quality Control Handbook, McGraw-Hill, 1974.

6. MIURA, T., Nippon no Kensetsu-Sangyo (Japanese Construction Industry), Shokokusha Publishing Co., Inc., 1977.

7. SHIMIZU CONSTRUCTION COMPANY, QC/QA Program Report, June 1983.

8. SHIMIZU CONSTRUCTION COMPANY, Total Quality Control of Shimizu Construction Company, 1979.