Survey on workshop objective

Survey on Workshop Objective

Problématique de l'atelier

Zur Fragestellung des Workshops

Cartoon by Lodewijk P. Sikkel
(Venice, 1983)

Survey on Workshop Objective

Problématique de l'atelier

Zur Fragestellung des Workshops

Marita KERSKEN-BRADLEY
Dr.-Ing.
Institut für Bautechnik
Berlin

Received her diploma in civil engineering and doctor's degree at the Technical University of Munich, where she was a research assistant from 1974–79. Since 1979 she is working at the Institut für Bautechnik, Berlin, and is engaged in fire protection, quality control, structural reliability.
Chairman Scientific Committee IABSE Workshop Rigi.

SUMMARY
A brief survey outlines the development of quality assurance ideas in the field of civil and structural engineering as well as the intention of this particular workshop. The need to consider the diverging concerns and problems of the various parties involved in the building process when implementing quality assurance procedures is emphasized. Eventually, an attempt is made to define the scope of quality assurance. Attention is also raised to the inherent threat in terms of over-formalized or inefficient, pretentious procedures.

RESUME
Les idées à la base du concept de l'assurance de la qualité dans le génie civil sont brièvement évoquées, et le but de cet atelier est présenté. L'attention est attirée sur la nécessité de tenir compte des différents intérêts et problèmes des personnes concernées par la construction, lors de l'étude de mesures propres à l'assurance de la qualité. Un essai est tenté de définir le domaine de l'assurance de la qualité, gardant à l'esprit les dangers inhérents à une telle procédure, de développer des méthodes trop sophistiquées ou inefficientes, voire prétentieuses.

ZUSAMMENFASSUNG
In einem kurzen Überblick werden die Entwicklung des Qualitätssicherungsgedankens im Bauwesen und der Zweck dieses speziellen Workshops dargestellt. Es wird auf die Notwendigkeit hingewiesen, bei der Verfolgung von Qualitätssicherungsmassnahmen die unterschiedlichen Interessen und Probleme der am Bau Beteiligten zu berücksichtigen. Das Gebiet der Qualitätssicherung wird versuchsweise umrissen, wobei auch auf die innewohnende Gefahr überformulierter oder nur scheinbar wirksamer Verfahren hingewiesen wird.

1. BACKGROUND

It is generally recognized, that the safety and serviceability of structures are affected as much - if not more - by the procedures for controlling (in terms of steering and managing) the planning, design and construction processes than by design verification and the choice of the right safety factors. This wider field of activity, concerned with the management of the entire building process, has become known as quality assurance.

Quality assurance concepts have been developed and applied in highly industrialized technologies, such as electronics or mechanics, for a considerable time; new and high risk technologies, e.g. aircraft and space engineering or nuclear-power technologies are strongly influenced by the needs and possibilities of quality assurance. For civil and structural engineering, however, quality assurance concepts are not yet fully developed. The construction industry differs from the aforementioned by a lower degree of industrialization in conjunction with strongly established traditions, by more restrictive economic constraints, and limited possibilities of formalizing procedures - to mention only a few aspects. Also, certain technical concepts, e.g. fail-safe, availability and redundancy concepts have different implications. Eventually, a different approach from those found appropriate for other industries may be necessary.

Traditionally quality assurance within the construction industry was more or less limited to a mere checking of material properties, sometimes supplemented by rather administrative site inspections and concluded by a formal acceptance procedure of the completed construction. Alternative concepts of quality assurance emphasized the importance of documentation allowing a precise recording of all relevant decisions and operations.

The limitations of traditional technical procedures - such as design verification, material checking and the like - if dealt with as isolated features disregarding the building process as a whole, was never denied. However, only the increasing preparedness among the profession to attempt open discussions on structural damage promoted the general acknowledgement of human and organizational errors as major causes for inadequate structural performance. This in turn emphasized the need to consider the entire building process as a complex system of decisions, operations and events, prone to errors at any stage, in order to allocate appropriate provisions.

A tentative outline of this ambitious approach was attempted in the "General Principles of Quality Assurance for Structures", prepared by the Joint Committee on Structural Safety (JCSS) and published by IABSE. Although the result of a joint study certain individuals as Julio Ferry Borges, Lars Östlund and Michael Baker should be mentioned, having strongly promoted and guided this publication. Definitely the JCSS activities profited from similar discussions in Switzerland in the context of a generalized reliability document (SIA 260) under the chairmanship of Jörg Schneider. A detailed elaboration of quality assurance with reference to concrete structures has just been finalized within the CEB under the guidance of Alvaro Garcia Meseguer.

The idea for a workshop on quality assurance emerged from the session on Safety Concepts at the X IABSE Congress in Vienna. It was felt, that in spite of considerable progress made in this field, the concept of quality assurance remained rather vague. The workshop was intended to serve several objectives. A modest objective was to provide a forum for engineers and scientists working in different fields for an exchange of views and thus to propagate the awareness for issues of quality assurance. A more ambitious objective was to seek an improved conceptual clarification of the notion 'quality assurance' as appropriate for civil and structural engineering. On the basis of an improved concept the resulting implications for the various fields and parties involved in or associated with the building process could be studied. Finally, it was also intended to identify problems in practical application and thus focus future research and

development.

It was understood, that basically the scope of such a workshop should not be confined to the performance of the load bearing structure alone but should also include all non-structural aspects of buildings relating to the general architectural design and the finishing of buildings (installations, insulation, linings, etc.). However, since almost all participants were expected to be civil or structural engineers, not familiar with these "architectural" tasks, the workshop would inevitably focus on structural aspects. But it may be concluded, that the basic results which are developed from the structural point of view apply in an analogous manner to the other fields of construction.

2. PARTIES INVOLVED AND THEIR OBJECTS OF CONCERN

As mentioned before we are basically concerned with the safety and serviceability of structures - or more generally: with the performance of structures during a certain time of service. The performance may be adequate, i.e. in accordance with predefined specifications, or inadequate, due to deterioration in appearance, restrictions in use, possibly requiring repair or even reconstruction in the case of severe structural damage.

A more conclusive evaluation of the performance is only possible by reference to the various parties involved. Obviously the client, the contractor, the designer, the building authority, the user, the insurer and also the neighbourhood will have different perceptions of adequate performance and in particular of the associated time period of concern. According to the objects of concern, the various problems encountered within the current building activities may be rated differently by the parties involved, thus suggesting a differing appreciation of quality assurance.

For example the building authorities in many countries are primarily concerned with the safety related performance throughout the lifetime of the structure. Requirements and provisions are governed by the risk generally accepted by the public and economic aspects only considered in a limited way. For the majority of structures the observed safety related performance is satisfactory and thus does not constitute a major problem. Some outstanding structural failures - some of which are discussed in the following Introductory Notes and Contributions - were found to be due to minor causes, which could have easily (i.e. at low costs) been avoided. For certain types of structures, e.g. some prestressed concrete bridge constructions, the long-term performance is not regarded as satisfactory, thus imposing the need for excessive inspections during use; more rigorous site inspections for new projects on behalf of the building authorities are under discussion, but the limited efficacy of isolated inspections is generally recognized. Hence, building authorities may very well be interested in more efficient systems for controlling the building process, not necessarily involving their own attendance. In some countries this view is also supported as a political issue in the context of withdrawing governmental control from areas where not indispensible.

The contractors on the other hand are basically concerned with the performance of the structure during construction and within the duration of guarantee. They are legitimately interested in maximizing their profit within the terms of contract and other legal constraints, whereby guarantee and liability specifications and modes of insurance definitely affect their financial calculations. One of their major problems is the common contract award procedure, where decisions mostly favour the lowest tender. This procedure does not promote high quality production as a management policy. In the case of an economic recession it inevitably results in bids below any sensible financial calculations - if not circumvented by some means, e.g. by legally "delicate" cooperation among the tenderers. On the other hand, if contractors were to offer a higher quality, this would be difficult to demonstrate by the contractor and even more difficult to

evaluate and quantify by the client. (Is the offered quality worth a e.g. 5% increase in the construction costs? Will this investment yield a corresponding saving with regard to the maintainance and repair costs?)

Companies (and offices) are also troubled by a decreasing qualification and motivation of personnel which, apart from directly affecting quality, may lead to an increase of costs. This situation (which is not unique to the building industry) promotes a greater concern for managerial aspects including education programs and revision of traditionally established organization patterns - if only from an economic point of view. Provisions of this kind are likewise promoted by the growing complexity of projects and increasing technical demands.

Contractors are often vexed by costly checking and documentation procedures imposed by clients or authorities (e.g. concrete testing of mass foundations) and which may appear to be purely administrative and ineffective in view of e.g. the site manager's knowledge of weak points. Hence, it may be worthwhile for the contractor to consider the benefit of taking more responsibility in the control of the building process, especially if costs in conjunction with quality are accepted as the issue for competition.

The clients, if not the later owners and users, actually only have business concerns; except if they as the vendors share certain guarantee or liability obligations with the contractor which are not covered by insurance. They may, however, consider to emphasize high quality as a special business policy.

The owners/users (depending on the contractural arrangement) are concerned with the performance of the structure throughout the intended service life. They are interested in minimizing the total costs (actually: maximizing the utility) including the costs of construction (or purchase), operation, maintenance, repair, and possibly demolition and reconstruction, referring to direct and indirect costs, minus the coverage from the contractor's guarantee. As concerns the safety related performance, they may have - according to legal specifications - a certain responsibility for which they may wish to apply separate considerations.

If the owners/users simultaneously act as clients they encounter problems when assessing the different tendering offers as to the actual quality they will receive (see also contractor's problems). They may also have difficulties in writing conclusive specifications; likewise, the clients do not have adequate tools available to efficiently differentiate the expected performance and service life according to their needs. As owners/users they have to deal with considerable uncertainties with regard to the operation costs as well as maintenance and repair costs which will be required and often lack the necessary information on cost-effective maintenance procedures.

The designers' (engineers/architects) objective will generally be, to provide the client with an economic design, which - if executed according to the specifications - will meet the needs and economic expectation of the client. Depending on the particular terms of contract, a designer (engineer/architect) may be responsible for the entire planning of the project including promotion and supervision on site, or only for certain features, e.g. the design calculations. In the latter case, a designer often encounters problems due to a lack of cooperation with those responsible for e.g. promotion where vital quality-related decisions are taken. Likewise, information on the standard of workmanship to be expected, may be missing at the design stage and eventually feedback of site data to the design office during execution may be poorly established. It is fairly evident, that the quality of the design is strongly influenced by the terms of contract, defining responsibilities and corresponding fees. As the "intellectuals" among the parties involved, the designers could improve their professional reputation by taking ethical responsibility with regard to the quality of their service.

Without elaborating the views of the various parties in more detail, it is ob-

vious that the owner/user is the party most directly affected by inadequate performance and thus has the strongest concern for an adequate standard of quality assurance.

3. SCOPE OF CONCERN

Every decision and operation throughout the entire building process, i.e. planning, design, construction and use will directly or indirectly affect the performance and cost of a structure - as well as any action (load) and event during construction and use. It is also well known that human and organizational "errors" at any stage of the building process are the most common cause for inadequate structural performance. Apart from directly affecting the structural performance, errors may cause organizational trouble, e.g. by affecting project schedules and in turn affecting the contractor's costs.

Consistent with the above, quality assurance is therefore concerned with the optimum effort employed for controlling errors by reducing the occurrence of errors and limiting the consequences of errors (through timely detection and correction). Consequently quality assurance is also concerned with boundary conditions promoting or interfering with an effective error control. These boundary conditions comprise contractual arrangements and legal constraints including guarantee and liability specifications, modes of insurance, and promoting, biding and awarding customs.

The exclusive reference to an "error control concept" can however be questioned: first of all the notion of "error" is not well defined; it inherently presumes a discretization into either erroneous or non-erroneous decisions and operations; in reality their rating may range anywhere between optimal and disastrous. Secondly, it may be argued that taking such a negative approach could be counterproductive to the actual intentions of quality assurance. A strong argument is, that the total cost of a structure does not only depend on the existence or non-existence of errors but also e.g. on the quality of the technical solutions and the standard of workmanship (with a continuous range), which again depends on the motivation of the people involved.

Nevertheless, referring to quality assurance by an "error control concept" is useful for the distinction between
- specific quality assurance provisions and
- the general scope of concern in the context of quality assurance.

Specific quality assurance provisions would thus be confined to distinct measures employed for an efficient error control, as identified before, and would consequently not include e.g. technical measures - a view favoured by many experts.

The general scope of concern then comprises all boundary conditions in terms of technical, managerial, organizational, legal and contractual aspects and in particular the recognition of their strong interrelation. Hence, there may very well be systems of contract - as well as technical solutions - which are prone to errors to a stronger degree than others. Likewise legal constraints, e.g. by codes, actually intended to promote safety, may be counterproductive by being e.g. too restrictive.

However, whilst the strong interrelation of these aspects of technical, organizational, legal, etc. nature is theoretically acknowledged, there is an increasing tendency in our societies to split responsibilities related to these aspects. Of course there are some good reasons for splitting responsibilities as are diverging interests of the various parties involved and limited professional knowledge. Nevertheless, this tendency often enforces isolated developments in the various fields. This is not a specific problem of the construction industry alone and thus was not to be elaborated at length within the workshop but it may receive more attention in the future. Definitely the issue of divided responsi-

bilities is one reason for engineers to be usually concerned with technical matters exclusively. Due to an increasing specialization among engineers themselves, responsibilities are split even in the technical field to an extent which produces isolated technical solutions, disregarding other constraints. It is presumably impossible to reverse the tendency for specialization and portioning of responsibilities. But definitely patterns of cooperation among parties and individuals should be improved. A broader acceptance of these interrelations and improved education could promote the mutual understanding among engineers on the one hand and among building authorities, contractors, architects, engineers and clients on the other hand.

4. HOW TO AVOID PAPER TIGERS

In the first of the following Introductory Notes, W. Bosshard introduces the provocative issue of quality assurance as a paper tiger. Because of the broad scope mentioned above, "papertigerness" is definitely an inherent danger to quality assurance.

Paper tigers may take different forms. For example I think it is rather difficult to elaborate quality assurance concepts in such a way that the number of words and pages are in a reasonable relation to the contents. Maybe this is an unavoidable phenomenon in a phase where one is still seeking for conceptual clarity.

Costly paper tigers may be encountered if the understanding of quality assurance were to be confined to documentation. A reasonable extent of documentation can only be specified if criteria are available for rating the decisions and operations during the building process, eligible for recording.

Another aspect - to which W. Bosshard actually refers - is the selling of "old for new". It is true that the basic ideas with regard to e.g. the need for a system-orientated (network) approach have been adopted intuitively by the profession for a long time. If we maintain this intuitive view, W. Bosshard may be right.

Avoiding paper tigers requires an improved evaluation of experience and appropriate feed-back of the information for e.g. the revision of standards and codes, the writing of clients' specifications, provisions relating to the organization of projects, maintenance procedures, etc. An evaluation of the available sources of information and problems associated with the collection of data and their assessment are outlined in the second Note by R.E. Melchers, M.J. Baker and F. Moses. A particular problem results from the very human desire to conceal information of an unfavourable kind such as cases of structural damage, especially if they may entail damage to the personal or company's reputation. Large scale clients and users and professional organizations could assume some responsibilities for this task in the future. Even if incidents are registered, severe difficulties are still encountered when attempting to rate e.g. the observed damage and to identify the actual circumstances.

Data control, supervision and checking as presented in the Note by G. Essunger and L. Östlund were formerly the exclusive elements of quality assurance/control and will continue to be significant elements in the application of advanced quality assurance concepts. Nevertheless these procedures may easily degenerate to paper tigers for various reasons: Many checks are performed because the procedure requires them and not because they are important or effective, i.e. checks are not consistently assigned to weak areas. Identification checks often decline to documentation procedures; checking of material properties and other structural properties are often performed at a stage too late to permit corrective measures at reasonable costs (or corresponding results are available only with a considerable delay in time). Checking and supervision may also be inefficient because the respective person is not sufficiently independent from the object of checking - or because he is too independent. This statement refers to the different aspects of "independence": the controller definitely needs sufficient authority

to order checks and corrective measures, if necessary. Likewise, the controller should not be directly engaged in the working process subject to control. However, the controller should simultaneously be sufficiently knowledgeable with regard to the weak points of the process to be controlled; it is often difficult to find (or to afford) an appropriate person for control tasks and sometimes certain compromises are necessary (especially with respect to an efficient internal control).

Common phrases in the context of quality assurance are: "minimizing total cost", "optimum allocation of effort", "identification of weak points", "need for a system-orientated approach", etc. On a preliminary conceptual level these ideas can certainly be dealt with in terms of general professional experience, common sense and logical reasoning. In practical decision making, however, these phrases may prove to be no more than paper tigers, if no tools are available for obtaining operational results. A common engineering tool for assisting decision making is the use of calculation models. The complexity of the building process and the numerous modes of structural performance emphasize the need for assisting models; however, because of this complexity probabilistic modelling has so far only been attempted for certain aspects. A survey of the available mathematical formulations and solutions is given in the Introductory Note by R. Rackwitz. The suggested approach is based on an investigation of the various possible events entailing failure of the structural system and allows formulation of the resulting probability. The various events, in turn, are traced with regard to their original causes (e.g. occurrence and non-detection of errors and flaws).

Sometimes Quality Assurance Manuals of companies, illustrating their quality assurance "systems" may turn out to be real paper tigers and the increasing use of word processors may contribute to this phenomenon. Likewise, quality assurance departments in companies - if not only a telephon number to begin with - may easily degenerate to an alibi function if not deliberately integrated into the company and project organization. An important task which may be allocated to a quality assurance department is the evaluation of experience and feedback within the company - an aspect which is emphasized in the Note by B. Hillemeier. On a company level this does not only refer to actual structural damage, but also to organizational trouble, problems of project scheduling and calculation (organizational weak points) and thus provides the basis for organizational improvements.

Detailed project schedules are often regarded as paper tigers whereas they do not necessarily deserve this bad reputation, especially if advanced methods of dynamic scheduling are applied - possibly including stochastic models for dealing with the various uncertainties. There obviously are limits to the reasonable extent of scheduling and planning, e.g. in view of not inhibiting creativity and the voluntary sharing of tasks or responsibilities in unforeseen and thus unscheduled situations. The argument of inhibiting or constraining personal involvement is often brought forth in the discussions on job descriptions and is also raised in the last Introductory Note by the authors C. Turkstra, F. Knoll and D. Allen as a serious disadvantage of overly tightened organizations.

Surely the list of potential paper tigers could be extended and this inherent threat to the efficiency of quality assurance procedures deserves attention. But maybe we should not be too concerned about paper tigers after all. As Julio Ferry Borges clearly illustrated in the concluding session, there is always a human being behind a paper tiger ... .

Leere Seite
Blank page
Page vide