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Autor: Meseguer, Alvaro G.
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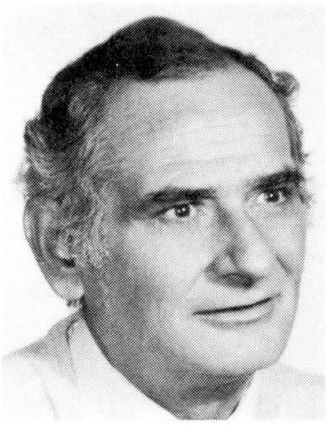
Quality Assurance: Basic Data from European Experience

Assurance de la qualité: résultats de l'expérience européenne

Qualitätssicherung: Ergebnisse aus europäischer Erfahrung

Alvaro G. MESEGUER
Prof. Dr.
Instituto Torroja, CSIC
Madrid, Spain



A. G. Meseguer, born 1934, received his civil engineering master's and doctor's degrees at Madrid Polytechnic University. Since 1959 he belongs to the Higher Council of Scientific Research (CSIC) where he obtained the research professor's degree in 1971. He has been an active member in CEB for 25 years and chairs the Section for the Construction Industry within EOQC.

SUMMARY

In the last decade a new mentality in the construction field has spread all over Europe. Differences between the traditional and the present approach are shown, as well as the various stages considered today in the building process. Quality assurance measures to prevent technical and human errors are briefly described.

RÉSUMÉ

Une nouvelle mentalité s'est installée depuis 10 ans dans le domaine de la construction, partout en Europe. L'auteur montre les différences entre les approches traditionnelles et nouvelles du processus de construction, ainsi que les différentes étapes considérées aujourd'hui. Il décrit les mesures prises pour éviter les erreurs techniques et humaines.

ZUSAMMENFASSUNG

Seit 10 Jahren breitet sich eine neue Grundeinstellung im Bauwesen Europas aus. Die Unterschiede zwischen dem traditionellen und dem heutigen Ablauf des Bauprozesses sowie die heute betrachteten Stufen werden erläutert. Massnahmen gegen technische Fehler und menschliches Versagen werden kurz beschrieben.

1.- INTRODUCTION

A new mentality in the construction field is spreading all over Europe since ten years ago. Tables 1 and 2 concerning basic and practical aspects show the main differences between the traditional and the present approach.

The new approach is applied in major projects and slowly moves towards medium projects. Operative methods for application of this philosophy are not yet available in a systematic way.

2.- THE BUILDING* PROCESS

The building process is considered as a set of activities going from NEED to USE. It starts from an user's need and ends in an user's satisfaction. The starting point and the arriving point being the same, the process is not linear but circular or, rather, spiral. The cause-effect mentality moves to a network mentality. The main stages in the process and their concern with quality are shown in Table 3.

3.- QUALITY ASSURANCE MEASURES (QAM)

At each stage (Table 3) a set of QAM are taken. The aim of these measures is to clarify situations, to identify responsibilities and to prevent technical and human errors.

Appropriate lists of QAM are not yet consolidated. A simple example of QAM lists dealing with stages A,B,E and H is offered in Table 4. Lists dealing with stages C, D and F are not presented because their length.

4.- PREVENTION OF TECHNICAL ERRORS

Measures against technical errors constitute Quality Control Systems and are applied in all stages of the building process. In Europe, quality control practices are in general satisfactory as far as materials and execution is concerned but they have to be improved in the field of planning and design.

Non-industrially produced materials are normally sampled and tested at the job.

Industrially produced materials are divided in two cathegories:

a) Non-traditional materials for which a standard does not exist. They are covered by an AGREMENT system, sponsored by UEAtc. Certificates are automatically convalidated from one country to another in western Europe.

b) Traditional materials are those covered by a standard. These materials are submitted to CERTIFICATION SCHEMES on national basis. The harmonization of national standards is a dificult task but this problem is expected to be overcome in some years, at least in the frame of the European Economic Community.

As far as Execution is concerned, contractors submit their own QA Programs describing the systems they follow to ensure the execution control. Some european Codes describe different levels of execution control and, in some cases, they are related with different values of partial safety coefficients. A formalized QA Manual for Contractors is under preparation within CEB (Comité Euro-international du Béton).

*) Building = Any construction

TABLE 1.- BASIC ASPECTS

	TRADITIONAL APPROACH	PRESENT APPROACH	REMARKS
The Building* process	DESIGN CONSTRUCTION	The same, plus: PLANNING AND USE	Simultaneous consideration of all stages Mutual influences
Reasoning	LINEAR	NET-WORK	Causes and effects interact each other
Requirements	SAFETY SERVICEABILITY DURABILITY ECONOMY AESTHETICS	The same, plus: AMBIENT ADEQUACY . . . . . ACCESIBILITY . . . . . . REPLACEABILITY . . . . . . ADAPTABILITY . . . . . . DESTRUCTIBILITY	- Community is taken into account - Inspection areas - Elements may have different life spans Easy replacement facilities without interrupting the function - Function varies with time. Reasonable degree of functional adaptability - Eventual demolition is taken into account in the design
Actions concept	LOADS AND IMPOSED DEFORMATIONS (Mechanical concept)	The same, plus: ENVIRONMENTAL ACTIONS (Physical-Chemical concept)	Designer's concern for Safety extended to Durability (Life time aspects)
Safety concept	DESIGNER CALCULATES FOR CODIFIED ACTIONS (Passive concept)	DESIGNER IDENTIFIES RISKS AND RESPONDS TO EACH ONE. (Active concept)	- Risks are either avoided, or neutralized through design, or accepted beforehand - Hazard Scenarios and Safety Plans are prepared by the designer

* Building = Any construction

TABLE 2 - PRACTICAL ASPECTS

		TRADITIONAL APPROACH	PRESENT APPROACH	REMARKS
Main concern		NEW STRUCTURES	EXISTING STRUCTURES	Increasing consideration to life time aspects
Leading parameters		MONEY TIME	The same, plus: QUALITY	Quality is focussed from the starting of the process
Parameter to be optimized		CONSTRUCTION COST	LIFE TIME COST	Life time cost includes construction cost and operating costs, e.g.: - maintenance (inspection, cleaning) - repair in case of damages - energy consumption - administration, guards, security
Emphasis in		EXECUTION	PLANNING and DESIGN	Earlier decissions involve stronger consequences
CONTROL OF	Materials	Acceptance tests at job	Quality certified beforehand (Certification Schemes)	- A Certification Scheme requires: a) a previous approval b) a production control, and c) an external inspection of b) - For Execution, the previous approval refers to the Contractor's QA Program
	Execution	Engineer controls Contractor	Contractor controls himself under the Engineer's supervision	
	Design	Exceptional	Fundamental	
Care for		TECHNICAL ERRORS	The same plus: ORGANIZATIONAL AND PERSONAL ERRORS	Quality Control extended to Quality Assurance

TABLE 3 — STAGES IN THE BUILDING* PROCESS

STAGE	ACTIVITY	GOAL	REMARKS
A	IDENTIFICATION OF THE NEEDS	TO FOCUS quality	Is a building* the best solution for the needs?
B C	PLANNING OF PROJECT PREDESIGN	TO DEFINE quality	Performance requirements
D	DESIGN	TO SPECIFY quality	Technical solutions
E	PLANNING OF CONSTRUCTION	TO OFFER quality TO DECIDE quality	- Preparation of basis for tender - Offers presentation: specific parameters - Decision
F	CONSTRUCTION	TO PRODUCE quality TO CONTROL quality	- Planning of execution - Execution
G	DELIVERY	TO VERIFY quality	- Building quality - Quality of documentation
H	USE	TO KEEP quality	- Maintenance - Periodical inspections

* Building = Any construction

(Source: CEB Task Group I|3 "Quality Assurance Program")

TABLE 4 - QUALITY ASSURANCE MEASURES

STAGE A - IDENTIFICATION OT THE NEEDS	STAGE B - PLANNING AND PROMOTING
- Description of actual and updated needs - Description of possible solutions to satisfy the needs - Justification that building is the best solution - Formal recording of who is responsible for the decision	- Appointement of the Project Manager - Investigation of actual requirements of the owner - List of authorities to be consulted - Description of restrictions (cost, time, legal, social, environmental, ambient impact) - Description of soil conditions

STAGE E - PLANNING OF CONSTRUCTION	STAGE H - USE
- Checking the design and fulfilling the lacunae - Preparation of basis for tender, including quality requirements and criteria to evaluate the offers - Assesing of contractors proposals for quality assurance - Consideration of the effect of a failing firm (bankruptcy) - Choice of the contractor	- Consideration if Commissioning is necessary - Application of the Utilisation Manual - Application of the Inspection Manual - Recording of changes and modifications

Source: CEB Task Group I|3 "Quality Assurance Program"

5.- PREVENTION OF HUMAN ERRORS

Human behaviour has to do with personal and organizational errors. It concerns all stages of the building process and is recognized as the main source of construction failures. In human behaviour the relevant variables are not numerical but literary as they have to be described with words and can not be described with figures: the level of professional knowledge, the degree of severity of an inspector, etc, are simple examples.

Literary variables can be mathematically studied by means of the fuzzy sets theory but practical engineers are not in a position of waiting for results from research experts. For the moment being, the best tools to be used in this field are cheking lists, event trees, fault trees and similar manegement technics. At the IABSE workshop of Rigi (1983) the human factor was deeply discussed; in the following, a simple methodology to deal with it is offered, based in studies carried out by BLAUT.

A.- Any task at any stage is considered to be divided in two phases:

a) Planning of the task
b) Execution of the task

B.- In the planning phase of a task, the following aspects must be assessed by means of appropriate check-lists (each check-list develops the underlined word):

1.- The goodness of the task definition
2.- The necessary means to carry out the task
3.- The necessary knowledge to carry out the task
4.- The quality of human communication between the participants
5.- The level of motivation of the participants

C.- The quality of the result depends on these five parameters, listed from less to more importance. Granted that the task is well defined, the influence of parameters 2, 3, 4 and 5 is recognized to follow the symbolic formula:

$$\text{Quality of Task} = (\text{Means}).\ (\text{Knowledge})^2.\ (\text{Communication})^3.(\text{Motivation})^n$$

were n can take values higher or lower than zero, thus leading either to a great quality or to a null quality.

D.- Check-lists for each parameter can be prepared with different degrees of complexity. As an example, two short lists concerning communication and motivation are shown in Tables 5 and 6.

E.- During the task execution the same ideas apply.

6.- RESEARCH IN PROGRESS

At present, much research is progressing in Europe on the field of Quality Assurance, mainly on national levels. As far as international level is concerned, the following bodies should be mentioned:

- Joint Committee on Structural Safety (JCSS), in the safety field. See IABSE Reports, Volume 35 "General Principles on Quality Assurance of Structures" 1981.

- IABSE, in the structural field. See IABSE Reports, Volume 47 "Workshop at Rigi: Quality Assurance within the Building Process", 1983.

- Comité Euro-international du Béton (CEB), in the concrete field. See Bulletin nº 157 "Quality control and quality assurance for concrete structures", Prague 1983.

- European Organization for Quality Control (EOQC), Section for Construction Industry, in the general construction field. See Proceedings of Symposia in Madrid 1976, Madrid 1979, Torino 1982 and Brussels 1985.

TABLE 5.- CHECK-LIST TO ASSESS THE GOODNESS OF COMMUNICATION

1.- Have all participants a clear description of the aim?

2.- Had all participants the opportunity to know each other?

3.- Had all participants the opportunity to add their own ideas?

4.- Were the various tasks clearly assigned to each participant?

5.- Are participants frenquently informed about the running of the work?

6.- Does each participant receive regularly a positive or negative evaluation about his/her work?

7.- Are critics and suggestions from participants accepted?

8.- Do all participants receive a feed-back about the results achieved?

TABLE 6.- CHECK-LIST TO ASSESS THE GOODNESS OF MOTIVATION

1.- Were all participants selected according to their knowledge and experience?

2.- Were and will be the real needs of participants (Maslow, Herzberg) taken into account?

3.- Are the participants well conducted by their inmediate superior?

4.- Are all chiefs giving a good example to the members of their teams?

5.- Are all chiefs taken care of their own motivation?