Zeitschrift: IABSE proceedings = Mémoires AIPC = IVBH Abhandlungen
Band: 13 (1989)
Heft: P-133: Quality assurance in the building process

Artikel: Quality assurance in the building process
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DOI: https://doi.org/10.5169/seals-41968

Quality Assurance in the Building Process

Assurance de la qualité dans le processus de la construction

Qualitätssicherung im Bauprozess

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SUMMARY

This paper deals in a rather subjective manner with Quality and Quality Assurance in the Building Process. The concepts discussed are largely influenced by European practice.

RÉSUMÉ

La contribution traite, de façon assez subjective, de la qualité et de l'assurance de la qualité dans la construction. Les idées présentées reflètent essentiellement la situation en Europe.

ZUSAMMENFASSUNG

Der vorliegende Beitrag befasst sich in recht subjektiver Weise mit Qualität und Qualitätssicherung im Bauprozess. Die dargestellten Gedanken spiegeln weitgehend die Verhältnisse in Europa.

Introduction

There are two fundamentally different perceptions of Quality Assurance: The one is as old as our profession and relates to the fact that we all try to do our best to create the quality our clients are looking for. Quality Assurance in this sense stands for "the application of a comprehensive set of measures and activities aimed at assuring desired qualities of the product in design, execution, manufacturing, installation, maintenance, repair and so on". This is how the IABSE Rigi Workshop in 1983 defined it [1].

The other definition of Quality Assurance was introduced mainly in conjunction with the construction of nuclear power plants and the associated public concern. There is a formal definition worked out by the American Society of Mechanical Engineers' Committee on Nuclear Quality Assurance. This committee defined Quality Assurance as "...all those planned and systematic actions necessary to provide ..." - and now one should pay attention to the subsequent wording: "... adequate confidence that an item or facility will perform satisfactorily in service".

Providing confidence, however, obviously leads to providing proof, and that, in turn, involves a lot of paperwork. The author is not against providing proof, but what comes out of this definition is a rather formal perception of the concept, one very much related to handbooks, forms, rubber stamps and signatures. Most of us are rather apprehensive with regard to these matters. And, in addition, just and merely providing confidence in something is not enough. Shouldn't we provide quality itself? Basically, it is a question of substance versus form. And, clearly, the issue is substance, not form.

It is necessary to go beyond definitions. In the following an attempt will be made to convince the reader that, with respect to Quality Assurance, the building industry's rather informal ways of action have a reasonably good record. We do quite well in our professional work [2]. But what we do should be done more consciously. Personal and collective attitudes in our professional activities and in the respective human relationships should be improved.

1. A Review of Concepts:

What, in fact, is the **Building Process**? For the author it is the texture woven of technical and organisational decisions and activities by all the people engaged in the building process from the first idea that a need may be satisfied by erecting a building, to, finally, its demolition. Important phases of this process are preparation, planning, erection, use. Important events are start of execution, start of use, taking out of service, and demolition. A very special characteristic of this process compared to other industrial products is the uniqueness of the process. Every building process is a prototype. We all know what this implies.

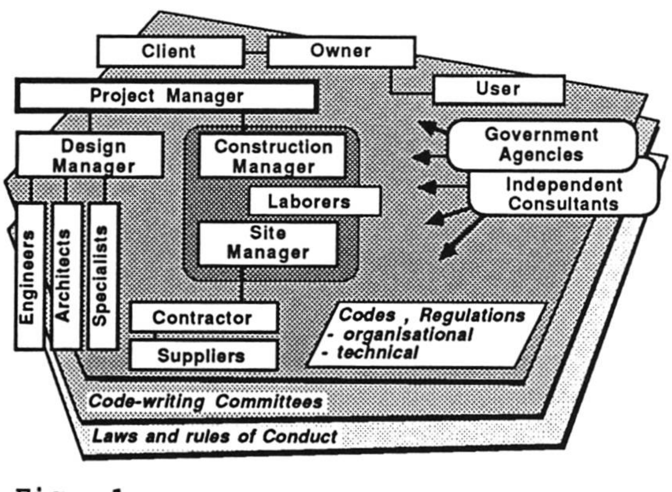


Fig. 1:
Those engaged in the Building Process

This Building Process is run by people, i.e. by **those engaged in the building process.** The participants together with the main relations are shown in Fig.1. First of all there is the "client", who is not always the subsequent "owner" and very rarely the final "user". Already this well-known differentiation introduces manifold problems into Quality Assurance.

The paper originates from a lecture delivered in the honor of Professor ir. A. L. Bouma, Delft NI

The client in most cases is represented within the Building Process by somebody with the necessary professional knowledge and experience. This experienced person is called here the "project manager".

He may delegate some of his obligations, tasks and duties to others, for instance to a design manager organizing the work of the "engineers", "architects" and "specialists" involved, and to a "construction manager" handling the execution works. The latter is the direct opposite of the "site manager", representing the "contractors" and "suppliers" on the site.

Possibly the concepts with which the reader is familiar are different, though what is described here is certainly understandable and may easily be related to the concepts he or she is used to.

In the centre of this process is the "labourer" or the site worker, who, as we all know, faces a very high professional risk to life and limb. In Switzerland the site worker's risk is the highest risk of any profession, and, astonishingly, also compared worldwide with site workers' professional risks. One in 2000 site workers per year is killed on site. This sad and almost incomprehensible fact puts much obligation on us in Switzerland.

There are "independent consultants" and "Government agencies" investigating the scene and the actions, which to a large extent are based on "Codes and Regulations", giving the organisational and technical rules to be applied. These may also be considered, at least indirectly, to be engaged in the Building Process, in addition to the respective "code writing committees". The whole is based on each country's constitutional, procedural and substantive "law" which finally reflects the structure of our "society". Meanwhile, "lawyers" (not shown in the figure) are also awaiting their opportunity.

The title of this paper also includes the notion **"Quality"**, which has many aspects. First of all, there are the qualities of the building itself like functionality, economy, aesthetics, safety, temperature and noise control etc, but also qualities which we as professionals are seeking, such as personal satisfaction, payment, profit (why not), and exemption from punishment. It goes without saying that all this pursuit of quality should pay regard to the limits and the framework of our political, social, legal and economic systems.

How can quality be quantified? That was and still is a critical question in this field and can lead to rather lengthy and ultimately fruitless discussions. In the author's opinion the best answer to this question is to measure quality as the complement to non-quality, i.e. as the complement to deficiencies and damage. The less we need to spend for repairs, deficiencies and damage, the better is the quality.

The aim of Quality Assurance in this sense would then be to keep non-quality, i.e. deficiencies and damage with affordable expenditures within acceptable limits. The questions are: How can this be done? Where is the best place to attack the problem? and Who, finally, is going to do it? These are the questions which are treated in the following.

Before that, however, there is a need to look more closely at the concept of Quality. For this purpose the concept of "Safety" is discussed, because it is central to our professional work.

2. Safety

Each person or group of persons involved in the Building Process sees something different under the notion "Safety".

The client may wonder if his initial aims will be fulfilled. The architect most probably will say that this is not one of his problems but rather that of the engineer. The engineer thinks in terms of "safety factor" though he knows very well that the problem is usually beyond narrow "safety factor" thinking. The contractor, on the other hand, is relying on the ability of the client to pay the bills and he might associate this to the notion "safety".

Building authorities, codes and codemakers: what these bodies understand by "safety" is, consulting many regulations, code clauses or entire codes, at least in Switzerland, worth a question mark, or two.

The state or society, however, is rather clear in stating aims such as public safety, legal security, protection of life, limb and property.

We try to be very clear in this respect in Switzerland and not to mix up safety matters with other mainly less important matters. We define safety in our field of application as "an acceptably small risk to people from failing structures, structural elements and technical equipment". This includes safety at work, safety of users and safety of third parties.

Clearly: Not buildings and structures are or should be safe but rather the people within their area of influence. This latter has to be seen in a very broad context of time and space. As an example let us look at a small bridge carrying a water pipe which, in the case of an earthquake and outbreak of fire is important for firefighting. Compare this small bridge with a long span bridge without important lifeline functions. The small bridge represents a much greater safety problem than the long span bridge. It is the latter, however, that receives much more attention and interest from profession and society.

Also long term consequences should be carefully considered. Safety problems are quite often found to be of a long-term nature as for instance corrosion, fatigue, pollution, and radiation.

Should the reader agree with the above definition of the term, the identification of safety problems is very easy. Simply ask the question: "Are people in danger if ...such and such a thing... fails?". If the answer is "Yes", then special care and attention is necessary. If the answer is "No" then one is probably facing a problem that might be quite easily solved by money and where economical considerations and even optimisation are possible.

These qualitative differences should be carefully considered. We should not mix up real safety problems with other generally somewhat secondary matters.

Since the author started asking himself this rather simple question when confronted with problems he feels quite at ease in engineering judgement. Asking this question ensures that one can better distinguish important from unimportant matters. It is suggested that readers try the simple question. They are sure to find it useful.

So much for the concept "Safety". The foregoing was meant to illustrate the scope of Quality and to show how complex the concepts are. One should keep in mind the above remarks on "Safety" when we proceed to hazards endangering structures and our profession.

3. Hazards and Measures

Quality, e.g. "Safety" in all its different facets, is endangered by hazards. These come from two very broad sources.

Hazards come from the **natural environment** of buildings and include wind, water, snow, ice, earthquakes, and avalanches. They arise also from temperature influences, from other natural physical or chemical attack and from geotechnical sources.

Hazards also arise very often from **human activities** and include above all human errors, mistakes, insufficient knowledge, negligence and ignorance in acti--

vities related to planning, design, contracting and execution. Hazards of this kind are also due to loss of control on use, to fire and accidents. These hazards include fatigue, lack of maintenance and influences from adjacent structures and facilities

Hazards are counteracted by protective measures. We distinguish five different kinds:

- Hazards may be **eliminated** by measures applied at the hazard source, for instance by avalanche prevention systems in triggering areas.
- Hazards may be **circumvented** by changing plans or concepts, e.g. by prohibiting construction in avalanche zones.
- Hazards may be **kept under control** by safety devices, warning systems, as well as by inspection and checking, e.g. by checking reinforcement placed prior to concreting.
- Hazards may be **overcome** by providing adequate safety margins, e.g. when designing structural parts.
- Finally, hazards may be taken as **acceptable risk**. It is impossible to do our work without accepting some risk, for instance the failure of structures under severe earthquakes.

As a rule, of course, a well balanced combination of measures should always be introduced. And it is also a good idea to check the adopted combination for possible gaps. We may, for instance, prohibit specific construction materials or systems in earthquake zones, design for operating-basis earthquakes, accept failure under more severe earthquakes, but nevertheless providing rescue services and lifelines, for instance bridges, roads and hospitals etc. for the worst case.

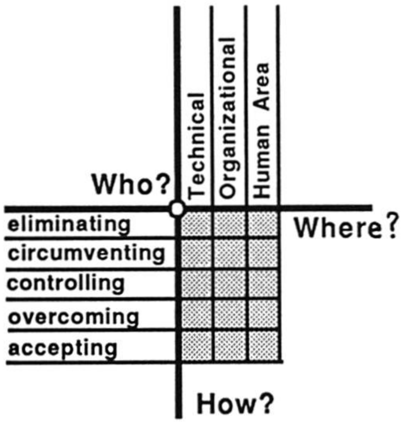


Fig. 2:
Measures: How? Where? Who?

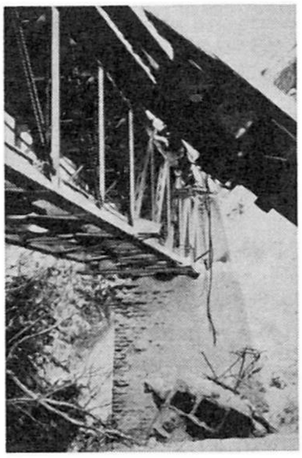
These five different kinds of measures are to be seen not only in relation to physical and geometrical parameters, say in relation to **technical aspects**, but also in relation to **organisational aspects** and information flow as well as in relation to the wide range of aspects related to **human behaviour** taking due account of the political and social environment including codes and bureaucracy.

The above is summarised in Fig. 2, in which the whole is related to three questions: How?, and Where? and Who? **How** should the hazards be counteracted: by eliminating, by circumventing, by controlling, in overcoming them, or by accepting the hazards as acceptable risk? **Where**, in which area should the problem be attacked: in the technical, the organisational or the human area? And finally, **who** schould carry out the work? The "Who" is indicated in the diagram as the third dimension to be covered later.

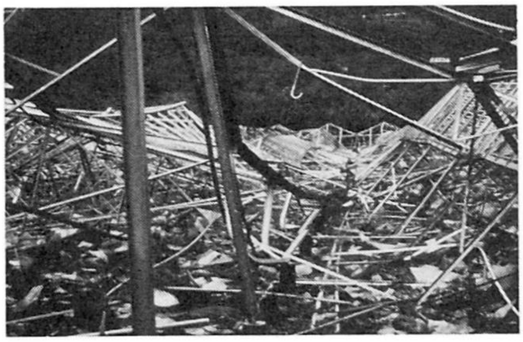
4. Examples

The following failure cases impressed the author and set him thinking. They also illustrate what was presented up to now in a more general manner. The reader should keep in mind the easily memorizable diagram of Fig. 2 and try to allocate the examples to one of the "where" versus "how" areas shown in the diagram. The photographs are not meant to show details but to give some visual effect to the wording.

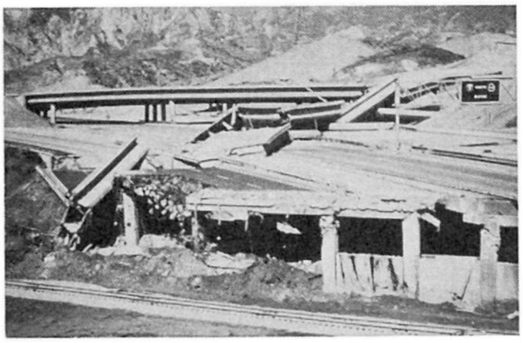
The first picture shows an avalanche in the Swiss alps that struck a building. This is accepted risk for stables not occupied in winter, but not for buildings inhabited by people. We provide avalanche maps that clearly show avalanche paths and endangered areas where special building regulations (mainly restrictions) apply. Appropriate counteracting measures are: accepting to some extent and circumventing, mainly through activities in the organisational area.



The next picture shows the Swiss Federal Railways off the rails: a train derailed by an avalanche. This is in fact not acceptable, but it is also not completely avoidable. We have warning systems and avalanche guards watching carefully during severe avalanche-prone climatic conditions. Except in rare cases these precautions work. Measures: some technical equipment installed to automatically trigger traffic signals in case of avalanches covering the rails, but mainly organisational and controlling measures employed.



To the far right is a greenhouse that collapsed under snow loading. The load bearing system, i.e. the heating system which was supposed to melt the snow, failed because of lack of maintenance. Maintenance is important.



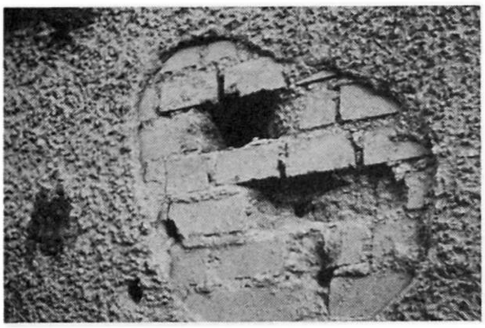
Here, collapsed bridges in California are to be seen, after an earthquake. This type of failure can definitely be avoided. Proper design of the supports and restraints against abnormal sway at the abutments is the effective means. Safety margins should also be applied to displacements. This involves measures in the technical area, overcoming by appropriate design and safety margins.

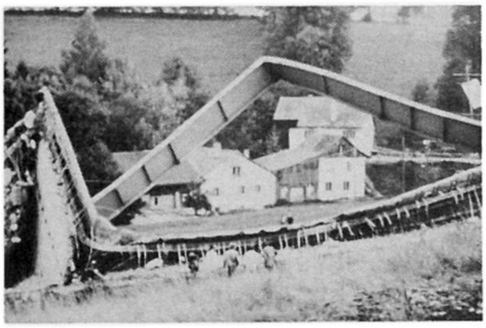
The next case concerns appartment blocks in Japan after an earthquake. The cause of failure was soil liquefaction. This adverse property of the soil could have been detected in time with the result of either refraining from construction or providing an adequate foundation system.

The next picture shows a reinforced concrete column in Italy after an earthquake. This is not an isolated case. Where are the stirrups necessary to provide ductility? Forgotten? Or "economised"? Insufficient knowledge? Negligence?

Or even worse? And what can be done to prevent such poor design from being executed? Would better control really help?

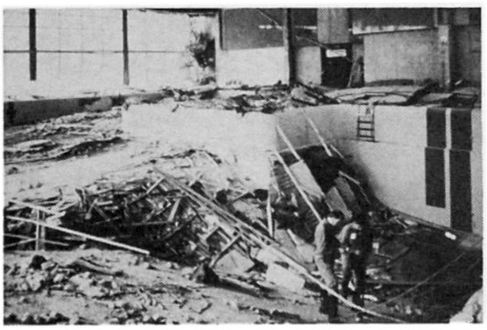
Further down you see some expensive cars under a collapsed roof formerly cantilevering from a column fixed to a wall together with a detail of the actual fixation of the structure to the wall. The structure and its fixation were probably designed by the car dealer himself. There is a lot to be said for the state or professional bodies setting up rules concerning who should be allowed to design structures. Whether these rules can be enforced and really help to prevent such occurrences is another question.

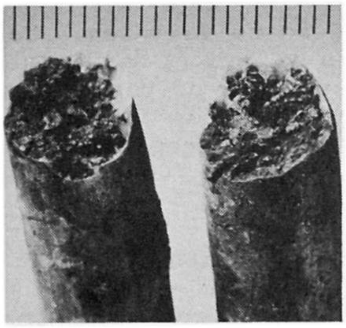




The next picture shows debris of what was intended to become a bridge. It involved an interesting erection procedure proposed by the contractor instead of the original design: put the steel beams in place, and then slide the concrete slab to be poured at one end in sections step by step onto and along the beams. There was a small slope in the direction of movement which was supposed to reduce the pushing force. Well, it turned out that there was high friction and so the contractor tried to overcome the problem by greasing the surfaces with water and graphite. All of a sudden the slab started to move downward under its own weight with the result shown. There was no device to hold back the slab should the friction be too low. And, more seriously, responsibilities were unclear. The designer thought the contractor would take care of the problem because it was his proposal. The contractor, on the other hand, assumed that the designer had the details under control. Here again we see the need to clarify responsibilities and duties.

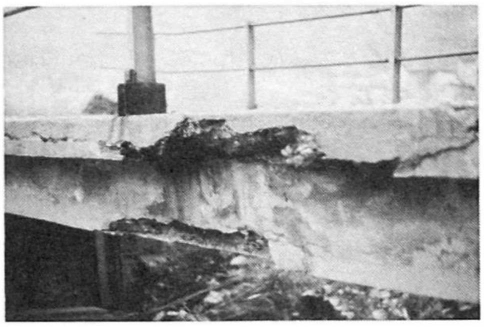
What you see next is the situation after the collapse of the suspended concrete ceiling over a swimming pool in Switzerland. Already 20 years ago account was taken of the corrosive environment by using stainless steel. Nevertheless chloride induced tension crack corrosion developed and the ceiling fell down killing 12 people. After the first few hangers failed the whole suspension system collapsed like a zip. There were warning signs well in advance but these were ignored and nobody took adequate action. In the wake of this event, however, quite a bit of thinking commenced in Switzerland.





Here, as a reminder, the hall of the Hyatt Regency Hotel in Kansas City after the collapse of the suspended walkways. The reason: a late change in a detail in favour of easier erection. Nobody noticed the error. 113 people were killed and 186 injured.

The last picture represents a rather different kind of failure: a bridge with severe durability problems. Repair work, sometimes demolition and reconstruction, is necessary for many structures in Switzerland as well as all over the world. We are, however, not educated in these issues nor do we educate our students in what they will most likely do to earn a living. This is another facet of Quality Assurance: Quality Assurance in regard to education and in education for the future.



So far with pictures, not meant to show details but to give some visual effect to the wording.

5. Lessons

Ten years ago one of my collaborators, Dr. M. Matousek, looked closely at 800 failure cases from the construction sector. Table 1 gives the most concise but still meaningful abstract of the survey [3]. The numbers shown are percentages. The first column gives the percentage of the number of cases, the second that of the damage expressed in financial units, and the last that of people injured and killed in the respective cases.

We comment briefly on parts of this table that particularly seem worth considering and try to draw some lessons from the survey.

As a matter of fact most damage is actually detected either during execution or in the first five years of the life of the structure. Only relatively little damage is observed in the subsequent years of the structure's life. That is not really astonishing because we look quite thoroughly into the future utilization when planning and designing a structure. Construction stages are often overlooked in design and execution. The lesson to be drawn is that we should not only consider the final stage, but also be carefully looking at the many construction stages.

In most failure cases loadbearing structures are the triggering part. Structures together with scaffolding are the cause of more than half of the cases and of more than three quarters of the damage and of the people injured and killed. The lesson is clear: it is a good idea to look carefully at loadbearing structures snd structural parts.

Accepted risks sometimes lead to failures. That is alright, because it is consciously accepted. In this relation it is interesting to see that 25% of the accepted cases relate to only 10% of the amount of financial damage. Recognized hazards are cases for investigation into how to decrease the consequences of possible failures. But clearly unacceptable in this respect is the 15% of people injured and killed. It certainly is unethical to consciously accept that people are killed in an activity.

The violation of codes and regulations, and of lists, drawings and instructions, but mainly of the very basic and elementary rules of art and practice are time and again the main causes of failure. These shortcomings account for 75% of all cases, for 90% of the amount of damage and for 85% of all people injured and killed in the observed 800 cases. This is the true field of Quality Assurance.

Percentage of	• cases	• amount of damage	• people injured and killed
Time of detection:			
execution until completion	58	52	70
first five years of use	15	6	3
after fifth year	24	30	10
alteration and demolition	3	12	17
Triggering part:			
structure	44	72	55
scaffolding	9	11	22
rest	47	17	23
Accepted risk:	**25**	**10**	**15**
Violation against ...	**75**	**90**	**85**
codes and regulations	8	17	11
lists, drawings, instructions	17	19	30
elementary rules of good practice	47	41	41
objectively unknown hazards	3	13	3
Basic cause:			
ignorance, carelessness and negligence	35	38	57
insufficient knowledge	25	27	21
forgetfulness, errors	15	7	8
underestimation of influences	13	6	8
objectively unknown hazards	4	21	3
rest	8	1	3

Table 1:
Review of 800 failure cases

Looking finally at the basic causes it is clear that we need to fight ignorance, carelessness and negligence wherever we find them. Selecting and educating people is important too. Insufficient knowledge ranks high in looking for the causes of failure. Lifelong education is important and is clearly not sufficiently recognized, especially by employers.

As a matter of fact, it was found in this investigation that 60% of these 800 failures could have been avoided by just paying very little additional attention. We will come back to this observation soon. Firstly, we try to be more explicit and to the point, addressing specifically so-called "managers" and "technical staff". The author gladly acknowledges drawing the main ideas from [4].

Some lessons for **"managers"**: Any division of responsibilities is a potential source of error and failure. Coordination is essentially a one-man's task. Continued supervision is essential where authority is delegated to unqualified persons. Hurried decisions or no adaption to changed conditions tend to lead to disasters. Reliance on learning by trial and error is too costly, especially in the field of management. Organisational matters must be dealt with and taught scientifically like technical matters.

And lessons for **"technical staff"**: The larger the project, the greater the risk of lack of attention to details. Specialists should not assume that they understand other specialists or believe that they are understood by others. Technical staff should not assume that managers, even if qualified as engineers, understand the technical consequences of their managerial decisions. Nevertheless managers usually hold technical staff responsible, even when deciding against their advice. And finally: Last minute changes are often wrong.

6. Hazards and Residual Hazards

All damage may finally be traced back to what we call **"Residual Hazards"**. This concept is badly understood in general, which is why it is clarified here referring to Fig. 3.

There is an **objective hazard potential** in every situation. Only a part of this potential is objectively known. Some of it is **objectively unknown** (for instance the issue of aerodynamic instability of suspension bridges before the Tacoma bridge failure) and forms the first input to what we call residual hazards. A part of what is objectively known from the hazard potential is **subjectively not recognized** and adds to the residual hazards. What is subjectively recognized is partly **neglected** due to different reasons - negligence, carelessness or ignorance - and again adds to the residual hazards.

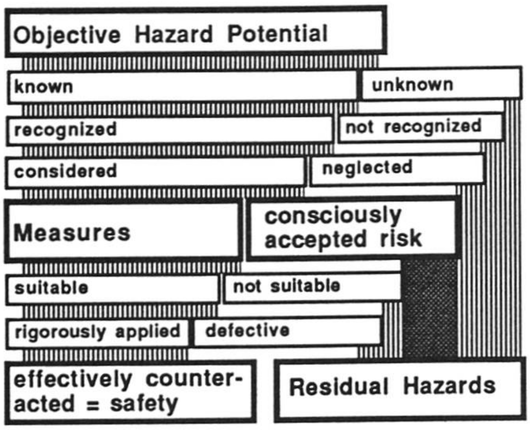


Fig. 3:
Safety and Residual Hazards

What is actually considered of the hazard potential, for instance in design, may be taken account of by counteracting **measures** or may be accepted as consciously **accepted risk**. This latter adds to the residual hazards but is the only - one is tempted to add, legitimate - part of the residual hazards.

We proceed with the scheme quickly. **Measures** may be **unsuitable** to really counteract the hazard (praying against snowfall in Switzerland for arguments' sake) or though being suitable, may be **defective** in its application. Both cases add further to the residual hazards.

Only that part of the objective hazard potential contained in a situation that is counteracted by suitable and rigorously applied measures is really adequately dealt with and leads to safety. All the rest are residual hazards.

If one looks at these contributions to the residual hazards more carefully one sees that, apart from accepted risks, all others are related to erroneous human activities, i.e. are related to what we normally call **"Human Error"**.

It is an essential part of Quality Assurance to develop and implement strategies against human error that are suitable to reduce these residual hazards. Such strategies are: Support of basic research, evaluation of experience and investigation of unclear phenomena, improvement of primary and lifelong education and training at all levels, motivation of people involved through clear allocation of duties and responsibilities and fighting all forms of negligence, carelessness and ignorance at all levels.

And related to unsuitable or defective measures we have: Thorough investigation of consequences before realising measures, and avoiding improvisations, motivation of people again through clear and definite instructions and documents and the implementation of adequate control procedures.

Only through a combined effort employing all these strategies against human error can quality and safety be achieved.

Thus Quality Assurance is essentially a fight against errors.

7. The Fight against Errors

The traditional weapon against errors is "checking". We check the numbers, analytical operations, the conformity to codes, the strength of millions of concrete cylinders all over the world, the number of signatures on drawings, in short: anything that can easily be checked and that lends itself to quantification. We are searching for the lost key under the lantern because there is more light there. We are not searching in front of the door, where we lost the key but where it unfortunately is dark.

The weapon "control" has become blunted through unreflected and improper use. As a result we see formalism all around us and stagnation of initiative and readiness to respond. We see frustration and a decline of professional pride, confidence and prestige of the engineering profession. This process has to be changed.

The author believes in the success of an approach which may be introduced under four keywords. First of all: **Motivation**: we need to give much more freedom to individual action to people engaged within clearly defined areas of responsibility. And **Simplification**: We need to avoid error-prone concepts, systems, structural forms and organisational schemes. And **Relaxation**: We need to delete all unnecessary constraints in matters of time schedule and money. And finally: **Control and checking** again, but now consciously applied at strategically well chosen and effective places.

Some of us believe, however, that Quality Assurance is just a new burden on the shoulders of the construction industry, and costs too much. We have to look at these arguments more closely.

8. Does Quality Assurance pay dividends?

Let us look at **benefits** first. From the review of the 800 failures it became clear that 60% of the non-quality costs could have been avoided. These non-quality costs include the total expenses necessary to compensate damage to life, limb and property and to compensate for deficiencies originating from faulty planning and execution, including openly negotiated and all so-called hidden costs. What are the reader's estimates percentagewise of the project costs?

The author interviewed quite a few people about this number. The answers varied between 3 and 10 percent of the project cost, i.e. rather big numbers (see also[5]). But looking more closely it is not at all astonishing because we include here all efforts made and time spent on correcting errors both in design offices and on the site.

The following considerations are based on an estimate of 5%. This means 1.5 Billion Swiss Francs per year paid out in Switzerland for non-quality. There is no good reason to think that other countries spend less in percentage of their respective construction industry's budget.

Investigations show that some 35% of the costs could be avoided without any additional activity just by adequate attention of the consecutive partners in the building process such as the engineer telling the architect immediately that there might be an error if he feels that there is one in the documents he received from the architect.

15% of the costs of non-quality are practically unavoidable. The remaining 50% may be detected through additional measures. If we assume that we are successful in half of these latter cases we end up with a realistic estimate which is that 60% of 5%, that is some 3% of the project costs could be saved by a more conscious application of Quality Assurance measures and by adequate care being taken by those involved in the building process.

And as to the **costs**: Let us assume that we add to a team of seven persons involved in planning, design and management one additional person thus allowing the team to try to achieve better quality. That would cost us an additional 15% of the costs related to the team. And because the cost of planning, design and management may be somewhere in the range of 10% of the project cost this would lead to an increase of the overall cost of about 15% of 10% which is 1.5%.

The same consideration applies for the execution. Let us add to a team of 25 people on the site one additional person thus allowing the team to try to achieve better quality. This would increase the manpower cost involved with the execution by some 4%, which itself is estimated to be in the range of 40% of the execution cost. This extra person adds another 4% times 40%, i.e. some 1.5% to the project costs.

Thus, one additional person per seven in planning, design and management of the project and one additional person per 25 on the building site would cost us roughly 3% of the project cost. This is our previous estimate of possible benefit of more conscious application of Quality Assurance measures and of adequate care being taken by those involved in the building process. But I am sure that the reduction in terms of human stress introduced by these extra personnel could quite possibly lead to an even higher percentage in terms of benefit.

For the author this is evidence enough. We really should start working along these lines. But a more conscious Quality Assurance would even reveal and certainly correct additional weaknesses in the Building Process, such as complicated organisation and information flow, unclearly defined competences, checks of no significance, imbalanced requirements, unclear aims and objectives. This all costs time, vexation and in the end additional money. An elimination of all these deficiencies would definitely make the cost-benefit relation positive.

So, why don't we start moving in this direction.

9. How to start?

In the author's opinion the client has to make the first step by making some concessions, e.g. by reducing the pressure on the time schedule and reducing moderately the pressure on prices, for instance by awarding the contract not always to the cheapest offer, but, possibly as a general rule, to the second cheapest. Designers and contractors should then use the freedom and relaxation introduced by the client in the sense of more circumspection and care.

The concessions on the part of the client will then pay off. Damage to life, limb and property will become less frequent, anxieties and frustration will diminish, and mutual confidence will grow where actually, at least in Europe, the battle is fought for survival between all parties involved in the Building Process, lawyers always confidently biding their time. We urgently need a fundamentally improved attitude in our professional relations.

Quality Assurance in this sense is not a new and additional burden placed on the shoulders of the building profession but a new basic attitude, improving in a positive sense the necessary cooperation of all people involved. The author is aware that what he is writing here may be looked upon as naïve and utopian. But sometimes even the ideal becomes true. He hopes for and looks forward to a better understanding between all people involved in the Building process.

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