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Quality Assurance – A Question of Professional Ethics, Management or Common Sense?

Assurance de la qualité – question d'éthique professionnelle, de management ou de bon sens?

Qualitätssicherung – Eine Frage der Berufsethik, des Managements
oder des gesunden Menschenverstands?

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SUMMARY

This Report is a dialogue between three engineers who attempt to outline the topic of quality assurance from the viewpoint of professional ethics, management and common sense. The main object of the discussion was to identify the very broad scope of quality assurance, rather than to elaborate working definitions and notions.

RÉSUMÉ

Ce rapport consiste en un dialogue entre trois ingénieurs, qui tentent de décrire le sujet de l'assurance de la qualité, du point de vue de l'éthique professionnelle, du management et du bon sens. L'objet essentiel de la discussion est de définir le concept d'assurance de la qualité plutôt que d'élaborer des définitions.

ZUSAMMENFASSUNG

Dieser Bericht ist ein Dialog dreier Ingenieure, die versuchen, das Thema Qualitätssicherung aus der Sicht der Berufsethik, des Managements und des gesunden Menschenverstandes zu umreissen. Im Rahmen der Diskussion war man in erster Linie bemüht, die breitgefächerte Problematik der Qualitätssicherung aufzuzeigen; Begriffsbestimmungen werden nur am Rande verfolgt.



We were asked to give an introduction on the topic of Quality Assurance, as a basis and guidance for the Symposium, identifying all main aspects and essential notions.

We very well acknowledged the necessity of the task, but frankly, we thought it would be rather boring to write a conventional contribution on this topic which then would be even more boring for any potential reader, who would presumably give up after the first half page. So we had the idea to present our contribution as a dialog, which really took place in a nice ambiance in Zürich in February 1985. Hence, we truly enjoyed preparing the contribution and hope that you, the reader, will at least follow us for a couple of pages (the secretary, however, was not very happy about her task to collect all this rigmarole from badly understandable sound tracks). The recorded discussion which was only slightly revised started as follows:

Marita: We should start with an attempt to define the goals of engineering activities; one option could be **Satisfying the Client**. What does this imply? Clients would surely be satisfied if we build structures for eternity with regard to their structural as well as to their functional aspects, including that structures may easily be adopted to any future need of the client. However - as a provocative remark - if we really could satisfy the client in this sense, we would be digging our own grave because gradually the construction industry and the faculty of engineers would run out of jobs. The alternative would be to build for a specified service life as the car industry does - for a life-time in this case of, say, fifty years.

Jörg: An example for your alternative are the bridges within the highway network in Italy. It was agreed between the private company erecting the network and the Italian State that the company shall own the highways (and collect the toll) for the first twenty years. Afterthen, the Italian State would take over the whole system. The bridges consequently were designed and built for the time the highways belong to the company. Now, after about twenty years, quite a number has to be repaired.

Marita: Actually, this is an amazing optimization job which has been performed by the private company.

Jörg: This optimization, however, failed since some of the bridges started to deteriorate after a period of ten years.

Marita: It would also fail if the bridges start deteriorating well after fifty years because then the private company would have invested too much.

Jörg: That is an interesting point. The client is a private company and sells or has sold the network by contract to an owner even before it was constructed. And the owner had practically no influence to define the product he was going to buy.

Marita: But I think that is legitimate. Did the state write into the contract that the bridges should have a service life of at least fifty years with a maximum annual maintenance rate of say 2% ?

Jörg: Maybe not. That's the mistake. And the private company just saw the fault and behaved adequately. But your point was different!

Walter: You were talking about the client and his needs.

Marita: Yes, if he specifies his needs then one option is to require a service life of fifty years at two percent maintenance cost. The other option would be: threehundred years of safe service-life with ideally zero maintenance cost. If the

client takes the second choice which all clients would prefer, then the building industry may gradually close down.

Jörg: There is enough need for new buildings because older buildings come out of fashion or do not serve their purpose anymore and are demolished.

Marita: No, not necessarily. The client could specify his needs by requiring that the structure should be adaptable to a huge variety of possible uses. In the case of a bridge you would not design for an expected traffic load but instead, design for the double or threefold expected traffic load. The more you **invest for considering prediction uncertainties** the greater the probability that the structure is fit for future uses.

Jörg: But with the example of a bridge this does not work. In Switzerland we demolished a bridge that was five years old. It was perfectly all right, but it was at the wrong place. How would your statement then work? You can't adapt a building to all needs even if it is fit for threehundred years and for all sort of traffic.

Walter: I am thinking of a different kind of client. The client I have in mind right now is a community which already has freeways, it has an airport, it has bridges, in fact it has everything. But the people have too much noise. So, they are looking for protection from noise and air pollution. Among the ideas they collected by a competition among engineers and architects are propositions to cover the freeway running through the community with a massive earth-covered structure. There is a process now going on within the community council, the parliament and the public of making up their minds on what should be done. And in this process there is a trade-off between the need they have, protection from noise, and cost. There is a choice between simple measures which bring little and very complete solutions which bring a lot and cost a lot. In fact, it's the **quality of the decision-making process** in this social environment which will lead to a good solution.

Marita: But the introduction to your argument actually supports my view. You said the community has an airport, schools, a community building, it has everything. The only need which is now left is a protection against noise and pollution. That will be the last building project for the next decades to come, because all their building needs are more or less satisfied. And if existing structures require no repair, well, the consequences are obvious.

Walter: No, that's not what happens, because it turns out that the solution best suited to their needs is a solution which requires an almost complete alteration of the built environment of the community. The project that won that competition was a project which proposed to them: "Look, by covering your freeway you repair the whole built environment of your community and you get the protection from noise as an additional bonus."

Marita: Yes, but as you yourself said, these types of jobs are already **repair jobs**, you are **repairing a rotten planning concept**; if you would have had a systematic quality assurance approach in decision making then you would not have to rebuild your community in order to repair the damage due to erroneous decisions.

Walter: I don't think so. The planning was perfectly alright twenty years ago. Because twenty years ago everybody, including the people in that community most badly wanted the freeway. I remember that. And in only twenty years their **value system** has completely changed. Now, they have the freeway and everything and notice that what they really miss is an intact built environment to live with their children and some green ...



Marita: Then you rely on the fact that the value system of a society will change with sufficient speed to provide the construction and engineering profession with jobs.

Jörg: But I also believe in that the building industry lives from **creating needs**. If this cover of the highway is built, it creates needs in other communities that suffer from the same problem. They see the solution to their problem and want the same. And it's not

Marita: That's an interesting aspect: To create needs means creation of jobs.

Jörg: Sure. But your first point was that creation of jobs or maintaining jobs is achieved by inserting defects that have to be repaired after twenty years and then gives labour to those in practice. And that is not the way we should tackle the problem.

Marita: But why should the building industry be so different to the other industries. Why should the building industry have the conviction to build for eternity?

Walter: Not for eternity, not by intentionally inserting defects.

Jörg: I know of a bridge which is going to be taken down because of some defects. I was involved with the design about twenty years ago in a time where we saw the erection costs of highways exploding. We aimed at and really succeeded in designing the bridge to be thirty percent cheaper, and better and more elegant. It just turned out now that the bridge possibly was too light for an increasingly heavier traffic.

Walter: We should do the best we can. I think the best projects are those which are in accordance with the **people's needs** at the time those projects are executed. It's probably best said by contrast: now nine projects out of ten are far behind of what most people perceive as current need. In Switzerland we have a very well tuned system to articulate the client's or the public's needs: the public vote.

Jörg: In most countries the public is not involved in the decision making. Anyhow, it is built what was decided ten years ago because it is in the program. There are a number of projects that have been realised in Switzerland and people were complaining when they saw the result of their positive vote in reality.

Walter: Over the last six years just about every project out of step with time has been voted down by the public in our country .

Marita: Aren't we discussing something different now, we are talking about **means** for the client to articulate his needs?

Walter: Yes, and this is exactly my point. Here is a client which in this case is a complex social structure and there are the designers. And the quality of the design is measured by the degree of agreement with the needs of the client and that necessitates precise articulation and safe communication of those needs. And that's the very essence of good projects.

Marita: You refer to the needs of the client in terms of architectural and societal aspects. What I am concerned about are the maintenance costs of structures.

Walter: I think this is subordinate to this question, because what comes first is the design of the building and I include in quality the **quality of the design** itself which can only be measured in terms of the correspondance between the client's needs and the project. This is quality of the project. I adhere to the

axiom that the earliest decisions are the most important and the most consequential ones. And the earliest decisions are those concerning the project itself. Voting down poor projects is a very efficient way to produce higher quality of projects.

Jörg: But look at another type of project. Look at offshore structures, oil platforms. What about votes there and the public? Who defines what the client and what the public wants in this case?

Walter: At first there is an oil company and its boss. This sounds simple. Let them run their business for a couple of years. As soon as the first oil platform catastrophe occurs you see other agents joining the game: governments who care about the safety of their people out there in the North Sea, insurance companies who object against the way things are done and do not want to insure this anymore, greenpeace people and rainbow warriors and consumer boycotts. Value systems and public needs are clarified by social conflict. Discussing the quality of projects you should **not reduce the issues to the purely technical matters.**

Marita: But you should certainly not forget the technical problems. As concerns platforms you are probably well aware of the lifetime aspects. You design for a specified lifetime and take into account expected operation and maintenance costs. In the analysis of a platform, for instance, you explicitly consider the return period of wave forces and prescribe inspection intervals.

Jörg: Yes, but somebody has to state acceptable return intervals and the like. You can't say you do it simply by optimization. However, I think we got blocked here. Can we stop discussing this subject and come to another point? Walter, you said, before we started recording the discussion, that one of the best ways towards good projects is to **strengthen the role of the designer.**

Walter: Yes, it seems to me that a designer needs enough leeway and competence to think on his own. He is the man who spends most time and intelligence on the project. Almost certainly he will come up with the idea that for instance this four lane freeway he was asked to design is by far overdimensioned. And he would notify the client.

Jörg: Maybe you ask too much of him. If he would go back to his client saying: "The task you gave to me is stupid, you should scale down the whole idea", he would never again get a new contract. I agree with you that as engineers we should always step back and reconsider what we do, but have we to go that far?

Walter: It is true that you ask too much from an individual designer requiring him to singlehandedly foresee future needs and changes of the value system. The solution is competition between alternative projects, public hearings and public vote. A good public discussion about the fundamental value questions behind a project must be based on formulated alternatives. At first sight this may not strengthen the role of the designer. In the long run it will: compare the role of the winner in a design competition with that of the one who got a direct mandate from a public administration. And again, Who is the client? The client in this case is the public that pays for the freeway. It is not the functionary who usually negotiates with the design engineer.

Jörg: But you would expect somebody representing the client to state the boundary conditions in this competition.

Walter: Yes, but these boundary conditions should only ensure a fair competition among possible alternatives

Marita: I agree. But this would require a redefinition of the **responsibility of the designer**, which would then also include to foresee future needs of the



community and to foresee possible changes of the value system.

Walter: It belongs to his responsibilities. Who else would care?

Marita: According to you, the engineer should have asked: "Why four lanes? Are the four lanes for reasons of safety or traffic?"

Jörg: That would have been a good question. But the point here is to strengthen the role of the designer.

Walter: O.K. then. In technical projects the engineer-designer should lead the way. There are non-technical projects where the architect-designer should lead the way. We are mainly speaking of projects where technology is more important than architecture. What happens very often with these projects is that the **leadership is placed in the wrong hands**, so that technical competence does not go along with the necessary authority to enforce technical measures and technical requirements.

Marita: Up to a certain extent there is a slight contradiction between the first part of our discussion where you said that we should emphasize environmental, societal and architectural aspects and reduce our concern for structural or technical optimization, and the second part of this discussion where ...

Walter: I disagree, because most of the environmental aspects are usually dealt with better by engineers than by architects, because they are used to handle natural laws in a more or less analytical manner. I don't agree with the idea that the architect is best qualified to take care of ...

Marita: If you allocate the main **responsibility** to the architect, well, then you run the risk that you do not arrive at optimal technical solutions.

Jörg: The fact is that if we assign architects the responsibility for technical matters, they do not really take over the responsibility. They just leave it with the engineer who does not have sufficient influence and often not enough self-confidence to make this situation clear. In my opinion strengthening the role of the designer is a question of putting overall responsibility to one man running the show then and ensuring that the work is done properly. Any project will run better if you assign full responsibility **to just one person** and not rely on big organisations and organizational charts and organigrams.

Walter: It is probably wrong to focuss on the architect because what usually happens nowadays is that the overall control is assigned to managers who are neither engineers nor architects ...

Marita: But business men ...

Walter: And this is worse because only few of these business men are generalists as they should be but instead are narrow-minded money people. This is the worst case of all, because you loose the architect and the engineer.

Jörg: Who is the designer of a big hotel project in Saudi-Arabia, for instance? It is certainly not the structural engineer.

Walter: As soon as projects have that many facets it is a role for a good architect.

Jörg: Is he the designer then? Do you refer to any key person in a project as the "designer", whatever his education is?

Walter: Yes, I would say so and I prefer a designer to a pure manager. Because the designer is concerned about "**Gestalt**". "**Gestalt**" of the hotel and the whole

environment. He would not look at the hotel as a single object. He would look at the change he is introducing into the given environment and at the people who will use it. If he really is a good designer he will probably even find out that they should not build the hotel.

Jörg: This probably is a new definition of the notion "designer": the one who cares about "Gestalt".

Walter: "Gestalt" is a very ambitious concept. It means **perfect union of form, function and meaning.**

Jörg: It's possibly symptomatic that also in the English language people use the word "Gestalt" when they try to express what you said.

Marita: But this implies that the person responsible for "Gestalt" is also very well aware of the technical problems because otherwise he would not arrive at this ideal solution.

Walter: We are in a very esoteric subject now, because "Gestalt" is an ideal. It exists as a guiding star. But this notion also applies to the organisation of a piece of teamwork. And it's the same notion of perfection. Once in a lifetime probably it really works.

Jörg: But let's come back to our theme. What has "Gestalt" to do with quality assurance?

Walter: I think quality assurance has a lot to do with **keeping things very simple**. Most people who have tried to design, either a building, an organization or a new product know that simplicity does not come about by itself. It comes about by finding "Gestalt" and it is simplicity which breeds good control. Because only simple things allow for efficient control.

Marita: I agree in the equivalence of simplicity and "Gestalt" because the ideal and the optimum is never complicated. It is the same when you are in scientific work, for instance, and you are working with huge formulas. You can be rather sure that you are wrong because nature is not complicated. Nature is simple. The truth and the reality are simple.

Jörg: That's an axiom.

Walter: And you probably see that by comparing to the opposite. Imagine things running out of control, you hire more people, most of them fools. And then you have little time to assign a well-defined task to each of them. And since most of them are fools, they will hire more people and assign badly defined tasks to them too. It's bureaucratic hybris.

Jörg: Fine, but let's come to discussing problems related to **contracts**, the link between design and execution. Walter, you said before we started recording, contract documents should not be piles of paper work, but just engineering drawings and the request to build the structure according to these drawings. Could you explain this a little bit more?

Walter: Yes, I should probably start with the negative aspects which may be observed today. **Tender documents** consist of thousands of pages of standard texts which are used to describe a building quantitatively in order to put dollars or Swiss francs on it. It's very formal and very linear. In the sense you tear down say a cathedral, place all the stones in a row and then you describe each stone: It's this amount of material, this amount of work and costs that much. And you line all this up linearly. Let's compare this with the way older engineers used to set up tender documents. They set out from the process of building and described



the individual steps from the excavation to concrete work and so on. They went through the whole process of constructing the cathedral mentally and described each individual step and the amount of work and materials needed in each step. I remember very well from the past that those documents were present on site and everybody involved with the construction used to consult these documents as a guide to build the building.

Marita: In our previous discussion you wanted to delete the domain of time. You wanted to look to the cathedral without considering the time axis. And I said, you should in a more or less precise manner describe the process of realization of the cathedral.

Walter: In a way you are right. But this comes from the historical evolution of those documents. It turns out that if you pursue the old procedure today it does not work on legal grounds, because it is not specific enough. It is not detailed enough in the sense of leaving too much leeway to those who want to cheat. So, the evolution from the original description of the building process to the huge piles of tender documents we have now is the result of the intention to learn from bad experience in making contracts. Those original documents were well used for good contracts by benevolent people. The guys who took those short and simple tender documents describing the building process, were essentially in the same boat with the client and the designer. They considered themselves members of the team and legal problems of confrontation between contractor and client and project engineers were not as frequent as they are now. Striving for **perfection in contracting**, we have spoiled more than we have repaired. What we have now is something which looks very comprehensive and also lends itself to manipulation by electronic data processing, but ...

Marita: I mean, if the specifications were truly comprehensive, the operational description of the process would result in the complete picture of the cathedral.

Walter: No, let me come to the last step. The most effective tender documents today are very complete engineering descriptions of the final product. What you have to assemble in tender documents is the complete engineering design giving all the structural elements, all the forces, the loads, the necessary details of the articulations and the joints, and there is no leeway left for misinterpretation. You should set out from the conception that at the moment the project is assigned to a contractor, he takes your tender documents and walks off to his draftsmen for the execution drawings.

Marita: But why do you stop with the complete engineering design and leave the execution drawings to the contractor?

Walter: Because it places the essential control function in the right hands. Making execution drawings is something which you can place under the legal force of the contractors contract. It is placed best in the contractor's hands and it's done best there and the engineer who has done the engineering design must then check those drawings. It is the right kind of subdivision because it ensures good control of what is being built afterwards.

Marita: But that means killing the **design-and-build contract**.

Walter: Yes, it's quite the opposite, because it places the designer in a strong position to discuss the project with the client and it results in an almost perfect specification of the purpose of the building. In addition, there is also a perfect basis for quality assurance in the execution because you know exactly what you have specified

Marita: The main role of the designer is then the translator of the client's needs into technical specifications. Do you think that the contractor due to his

specific but legitimate interests cannot fulfil this role up to the same extent as an independent consulting designer?

Jörg: This is true. But then what about all these **general contractors?** That's the complete opposite of what you are proposing. The trend goes towards general contractors, general designer-contractors or whatever their names are.

Walter: I disagree. There is a general disillusion among many clients I know about general contractors.

Marita: The original idea behind general contracting was probably closely linked with the quality assurance idea in terms of ensuring a coordinated and systematic approach to a project. I think one argument in favour of the general contractor is that he assures information flow and technical cooperation between the planning department and site, whereas a designer's office may not be very well aware of site constraints and specific problems of execution.

Walter: You should question the true interests of each one in the process. How does a designer succeed in his business? He must be able to attain a profile of a man who can communicate and discuss with clients and clarify the client's intentions to a point where a good contract can be made.

Jörg: But general contractors claim to be able to do that.

Marita: If the general contractor is general enough he has no personal interests in pursuing a certain solution. Then, theoretically the same degree of consultancy should be available to the client as in the case of an independent designer.

Walter: There is an important difference. The general contractor will play the game of the market place and by doing this well, he will benefit from it, for himself. And that's not a legitimate position to deal with the client.

Marita: But **how is the designer paid?** Usually, the designer is paid in percentage of the building costs. So, his main interest would theoretically be to make a project as expensive as possible. And that is not legitimate either.

Walter: I have always tried to convince our engineering society to change this fee system. I think the designer should be paid on a time-basis. And he should be paid much better than now.

Jörg: Are lawyers paid on a time-basis?

Marita: More or less yes, but for instance the American lawyers are paid by success. If they loose a case they don't get paid.

Jörg: I like the idea of **getting paid for success.** And one solution to the salary problem of the designer would be: estimate at best what the structure could cost and then get paid by a percentage of the amount of money you save through your work.

Walter: But who makes the estimate?

Jörg: That's the problem. But there is some sense in it, especially when you hire an expert. You could ask: How much do you save for me and I pay you twenty percent of that...

Marita: Do you mean savings on **building costs** or on **total life-time costs?** Because you can easily reduce the building costs by ...

Jörg: One should define that. That's important again. But I am not so sure that



you can save very much in building costs on the account of maintenance costs. You save much more in choosing another kind of carpet.

Marita: Coming back to the problem of contracting: Would you, Walter, as a designer, pre-specify the operation schedule and details of mode of execution?

Walter: No, I would not do that. Very good examples are modern large bridges, because there most of the cost elements are directly proportional to the time it takes to build the bridge. A week is just a fixed amount of money for the contractor. And so he is in a very clear situation where speed is about everything.

Marita: But what you definitely should specify, and that would bring us to the next point is: **Control procedures.** According to that aspect you should insert control stops within the execution process and specify which operations require specific control.

Walter: I would try not to interfere with the process. I would state in the tender documents : Your final product will be checked in the following way, it will be accepted if the following conditions are fullfilled and so on. But this applies to the final product only.

Marita: But you would specify the list of compliance control tests which you would perform for instance on behalf of the client and you may in addition specify control procedures which you require the contractor to perform and to certify .

Walter: In those examples which I have in mind, I think virtually all of these controls were pre-specified in codes we already had. I would only make reference to codes.

Marita: Another interesting aspect would be: Would you also specify organizational requirements. Would you require, for instance, the contractor to have a quality assurance department or to make available his organization charts?

Walter: The kind of construction I have been involved with was small and medium size rather than very large structures.

Marita: I would not consider this as a problem related to the size of a project; also for small projects you may want to give the client some guidance on the **selection of the contractor** apart from the minimum price criterion. You may want to make sure that the contractor adheres to certain management principles and may want to assess the contractor on the basis of a **quality audit**. I agree, within a small country, this may not be an important issue, because you may have personal experience with regard to all possible contractors.

Walter: In my area of activity, the kind of information I have collected over the years is that for me a contractor consists of the heads of the company and of the site managers. In principle, everything which comes below them is interchangeable. The **quality of a contractor** depends of the quality attitude of the heads of the company. You can see this by the way they educate their people, whether they organise courses, promote exchange of experience, and so on. There are very large variations in this respect, of course.

Marita: You know this from your personal experience as a designer and you should actually transmit this knowledge to the client. You may do this in a formal manner or in some personal way.

Walter: In fact, I do it in a personal manner.

Jörg: But you do this in your quite narrow field based on the experience with a

sufficient number of completed jobs. But given the hotel in Saudi-Arabia mentioned before, you get offers from all over the world and you might not have enough personal experience. You, Marita, mentioned auditing as a possible issue.

Marita: I would first of all specify certain minimum requirements, thus reducing the number of tenders a priori, for instance by asking for a certain number of comparable reference projects, or for a certain type of quality assurance system, then ...

Jörg: I am sorry, but this happens all on paper. I want to see the people, that's quality audit to me, have personal contacts and conversations with the people. And then I would ask for assurance that these people I consider qualified will stay with the project during the execution. I should like to be asked whether I agree in case they have to be exchanged because of some reasons.

Marita: That of course very much strengthens the role of the designer.

Walter: I think it is time to say, that the real life of the designer is about twenty percent of what I was trying to introduce here as his role. In reality we are very weak, we are under pressure from everywhere. Very seldom we are asked about these matters. I think, out of a hundred civil engineers who act as designers in Switzerland about fifty could answer, but only about ten are high standing enough to be asked such things by the client. This says very much about the low standing of our profession.

Jörg: They could answer and really consult the client in choosing the contractor, but they are just asked about the **lowest bidder**. Unfortunately, the clients in most cases follow just this simple argument. They do not follow your proposition if the price of the one you propose is three percent higher.

Walter: No, they don't. They say: well, for that we finally have lawyers. And they are wrong because there is a very wide gray zone within which you do not yet call in the lawyers but you have a miserable building.

Jörg: I really think we need some **relaxation** here, relaxation with regard to money. Maybe we need a rule that says that not the cheapest bidder will get the contract but maybe the second lowest bid, or, at least, not always the cheapest. Practically, we have a very strict rule to assign the contract to the cheapest which certainly leads to less quality, but also to a reduced motivation to look for quality. The contractor is forced to look just for the cheapest solution, not for the optimal one.

Marita: I think, any general rule in that context is wrong because you have to consider prices, impressions from auditing and so on and then ponder the various aspects using professional judgement.

Jörg: Well, but then you have the difficulty to translate personal confidence you have in a contractor into **Swiss Francs**, which is very difficult.

Marita: That amounts to a similar role of the designer as we were discussing before. First the designer has to interpret the needs of the client in terms of technical specifications and then he has to convey his impression on the quality of the tenders in relation to their price back to the client.

Jörg: But I can't help. Finally it ends up with saying that this opinion I have upon this contractor is worth three percent. I don't see that, in Switzerland at least, the client follows this advise. He says: three percent, that's much money, that's maybe a million Swiss Francs.

Marita: But this is ridiculous because if the same client goes downtown in order



to buy himself a coat or a suit, well, then he very well is aware of the fact that if he buys a suit for two hundred he will generally get less quality than if he buys a suit for twohundred and fifty...

Jörg: Of course, there are other examples where he would not ask for the cheapest bid, for instance in choosing a lawyer or surgery medical doctor. But he asks for the cheapest contractor, he sometimes even asks for the cheapest designer.

Marita: Then we may very well question the actual expectations of the client.

Walter: And that's the mistake of us professionals. We are not teaching the client any concept other than price to select. I have never done it, but it seems to me that in the line of that "Gestalt" argument of before we might approach the contractor. We might, as one element of decision, ask him about his concept to put this structure up. This might reveale quite a lot.

Jörg: It may depend then on the linguistic capability of the one the contractor delegates to tell you the concept. Finally if you introduce "Gestalt" again here, maybe you introduce a very fuzzy notion which does not help much in this context. Actually, there is the difficulty to translate confidence you have in a contractor into monetary units because finally you should make a proposal which yields an optimum to the client, hopefully.

Walter: Yes, but let's be specific. You have in your tender documents the topic "Installations" in most cases. Installations, behind which there should be a concept. The contractor needs, physically, a couple of installations to put this building up. You could ask him: what is your concept behind these installations? And then you could compare these concepts. We did this once, and there were very clear differences in attitude and in responsibility and this gave a good picture of...

Marita: Yes, but this is some kind of auditing, auditing with repect to intended operation procedures ...

Jörg: I think we should advise the client that the final sum in a bid which may lead to assigning a contract is a rather weak indicator in the whole building process. But actually, also structural engineers sometimes do not include quality arguments for instance when comparing mild steel reinforced flat slabs to prestressed flat slabs just on the basis of the price per square meter. But let's come back to "relaxation". That is a more relaxed way of handling tender problems we should look for. But I think we need also a more relaxed way of handling time-schedule problems.

Marita: Money and time is the same, and possibly also the number of people involved.

Walter: Less time can lead to better construction.

Jörg: When I say more time, I mean more time compared to what we usually experience. We are pressed, there is much time spent with previous discussions and then they assign the contract and ...

Marita: The pressure does not only come from the client, but also from the management of the contracting firm towards the site managers, maybe because the bid was ten percent too low and the site manager is urged to be twenty percent faster in order to compensate.

Walter: I remember a very good example which is just the opposite of what you said. For a given job we got five offers and the main difference was in the price of the erection of the steel structure. One of the contractors claimed that he

would be able to erect threehundred tons of steelwork in one month with five people. Another one took two months for the same amount of steel with more people. It turned out that the first company had actually shown in several instances that they were able to do it and even in a qualitatively better way then the other ones. The difference was in the concept of the erection procedure.

Marita: O.K. , but this is something which you can only find out by auditing.

Walter: In the case of those steel structure it turned out that in the older and well established steel constructing companies, they usually have a division that takes care of erection. This is a very well established bureaucratic unit, which has its own bureaucratic ways of functioning, and their interest is to keep their jobs in their division. And in the other case they do not have a separate division which does the erection, but they have only a small group of montage people and they act under the direction of a very clever overall chief.

Marita: And now we are getting to one of the aspects which I consider most essential in the context of quality assurance, that is the **management and organisation of firms**. It is essential how firms design their functional units. Your example is an excellent case to describe the difference between a traditional hierarchical set-up which is generally immobile, cannot adapt to new concepts and new needs, in comparison to companies which have matrix organizations or other forms where ad hoc units can be created to meet new challenges.

Walter: In fact in this case of this specific steel structure it turned out that the companies who required twice as many people and twice as much time had very much experience. After the first two or three similar jobs and some bad experience they increased their personnel, their bureaucratic activities and their care and everything. They had never had a really clever manager who solved the very central problems. The company that got the job had a very clever manager, had a very good and clever concept and had learned from bad experience too, but did not tackle the problems by increasing bureaucracy and caution but by **avoiding the problems**. So it was the difference between killing the problem with more manpower and time on one side and avoiding the problems with good ideas. So, it's still the good idea that makes for quality and it's not the bureaucratic activity...

Marita: It not only pays for quality but good ideas are probably the best business investments.

Walter: Yes, it's again the "Gestalt" argument because you do not get good erection procedures by adding additional devices and caution and additional personnel ...

Marita: But not as a general rule. In some cases it could be the right strategy. But the general conclusion is, that management - actually in the very original sense of a sound conduct of operational procedures - is essential for quality assurance. Even if conduction of procedures is pursued exclusively from the business point of view, this will generally also contribute to quality.

Walter: Yes, and very much so because our job sites today are heavily relying on expensive and energy intensive machinery. The essential thing is not only how many people, but how to use that machinery in an efficient way. And this is a matter of intelligence ...

Marita: And **operations research**. Yes, nothing else.

Walter: And I must say, in this kind of medium size operation it is not solved by operations research but by a clever concept.

Jörg: By a clever person, actually.



Marita: I think operations research includes anything from sound common sense to detailed scientific investigations.

Jörg: Well, when I said time is important, we need more time, then I state this because we are rather often pressed to react quickly rather than to think thoroughly before acting in a situation. A little bit more time would very often help in finding better solutions.

Walter: Yes, but there is an important point right here. More time is enormously important as long as you are working with brains and pencil and paper. There a little bit more time can be an enormous benefit. But as soon as the operation itself starts, more time means just...

Jörg: I completely agree, I mean time for planning ...

Walter: One could even say: give us years to make up our minds on what the client really needs, give us a year for good planning and for schedules, and then give us only a very short limited time to build it and make everybody aware that they have to concentrate on that short period where everything must work very smoothly and very efficiently. There is no point in extending the material operation.

Marita: This may require a greater extent of industrialisation on site than we have nowadays.

Jörg: I have another concept which was not touched up to now, that is **Motivation**. I felt motivated a lot of times, first by my teachers and then by my different bosses. I felt that this was a very important point in my life ...

Marita: I always get very bored when I hear the word motivation...

Jörg: But we missed that concept in our discussion up to now and we rather often also miss it in practice ...

Marita: We did not miss the concept because motivation is an essential aspect of good management.

Jörg: I agree, but we did not discuss the notion management too much up to now. There are different concepts, management by dictatorship, by communication, by what do I know. Management by motivation, that is what my teachers and bosses did with me, up to now.

Marita: Motivation is one of the very elementary common places of management. We obviously cannot discuss motivation without reference to management. Twenty years ago we had the management by bossing but gradually it is broadly acknowledged that management by cooperation is the right thing to do. You only have to take a look at recent management publications.

Jörg: Only rather a few old bosses will read publications on management. This all might be familiar to the new generation. By the way, I was motivated mostly by being charged with competence and responsibility.

Marita: You may be right. The construction industry may be more or less a "developing country" with respect to management. So we have to educate the construction industry in elementary principles of management. Not necessarily we ourselves, but we have to provide for means that new knowledge in this field is also available to the managers in the construction industry.

Jörg: So, hopefully in Tokyo some people will stand up and talk on such issues and possibilities, not just on what should be done but how they do it in their

company. I think we can learn a lot in this respect from the Japanese colleagues.

Walter: I think there is a relation between what you say about motivation and the allotment of time to things. I remember the case when someone asked a team of civil engineers to find ways to shorten a given, well known construction process by a factor of 100. It was a challenge at the border of the impossible. We were very motivated - mainly because we had plenty of time to study possible solutions - and we succeeded. It is a total turnoff to plan an ordinary structure in, say, 60% of the time usually required to do the planning job.

Marita: But before we admitted that our construction industry in general is not yet prepared to work in a totally industrialized manner such that for instance all working procedures are sub-optimized independent units which can be arranged to meet any need of the particular project.

Walter: I don't think it's just industrialisation. To an engineer, it's intelligence, economy, optimization and "Gestalt" which motivates and it's waste of material and lack of "Gestalt" that turn off. I think that the common ground between all my examples is the overwhelming importance of thinking and preparing things beforehand.

Marita: Yes, but not only in the designer's office, but also in the contractor's planning office. A frequent attitude in contracting firms is, that the planning office is a more or less superfluous institution because money is made or lost on site. The office staff is considered only to interfere with the "real" building process. The application of, for instance, dynamic project scheduling is often looked upon as the toy poodle of some office guys and is not acknowledged as a tool for an optimization of operation procedures on site.

Jörg: From the client's point of view, contractors should solve their tasks, and whether this is done in an optimal way, that's up to them.

Marita: No, from the client's point of view you have to be sure that contractors solve their task in an optimal manner, because if their budgeting and scheduling is poor, the client is prone to receive poor quality.

Jörg: No, it's their business. Their task includes quality. The task is: build that structure or whatever it is with the specified quality within the agreed upon time limit.

Marita: The point is, that a complete description of quality expectations is impossible. In view of this deficiency the client should be concerned about the conditions of operation, such that he has sufficient confidence to receive his quality expectation. This requires an appraisal of the contractor with regard to his strategies in solving tasks, for instance whether he allocates his resources in an optimum manner.

Jörg: O.K., in the sense of auditing - as we already discussed - I agree. But I am convinced that contractors need freedom to perform their individual tasks. It is up to them to choose their strategies. And it's up to the designer together with the client to specify the expectations. But there is another point. One of the questions I was asked several times is: what does the title of the symposium really mean. Is it Safety-and-Quality assurance, or Safety Assurance and Quality Assurance, and the question then is, whether safety is quality or something different.

Walter: I usually set out from the set of thinkable solutions. Then there is a subset of solutions that are possible within the natural laws, that is for instance structures that will not collapse immediately. And well within this set there is a smaller subset which is safe, which is a definition made by society in



historical ways. And well within this subset of safe structures there is a subset which is acceptable to the client. Within this set we have to seek an optimum in terms of the clients value system. That's quality to him. And the client is not allowed to step outside of the safe domain. And the safe domain is by definition well inside the set of possible solutions.

Jörg: So you say quality is whatever the client wants, but **safety is the constraint society sets to his objectives.**

Walter: If you assure quality to the client, safety by definition is included. Quality is more strict than safety. There are structures which are safe but which are not acceptable to the client.

Jörg: Satisfaction of the client within the constraints of safety. And the notion safety **relates to people endangered** by our decisions directly and indirectly including delayed consequences. Something may not be a safety problem for myself and my actual environment, but it may severely affect the safety of my children.

Walter: Yes, but that is the misconception of those who want to separate safety problems from fatigue problems or durability problems.

Jörg: It also includes long term problems arising for instance from nuclear power plants, misuse or overuse of material and energy resources and so on. Often the immediate risks are very small but we are not aware or simply do not know what happens within, say, a period of fifty years. Most people think, however, that if this slab comes down on my head and I get killed, that is a safety problem. Adding to what I said before, a safety problem may also be a small defect in a valve of the water supply system that in case of an earthquake gets virulent and stops the water supply for fire fighting.

Marita: The only difference between short term safety problems and long term problems is that **long term predictions** are associated with more uncertainty than **short term predictions**.

Jörg: Not only long and short term but also direct and indirect effects, which hopefully helps a little bit in order to escape the quite narrow field of structural safety.

Walter: And safety alone is probably not all society sets as requirements on buildings. I refer also to noise, pollution and the like.

Marita: You may summarize: Safety of people and their environment, within their environment.

Jörg: O.K., the goals may be clear, but in the end, what does the notion "**quality assurance**" mean?

Marita: Certainly not only "**quality control**", and certainly not just mere documentation ...

Jörg: And certainly not just those actions necessary to provide confidence of people that the product will have desired qualities, as I recently heard in a lecture presented by an eminent expert from the nuclear industry.

Walter: I think quality assurance is about everybody taking care of his own business, appropriately. The owner has to do it for his building, and the contractor has to do it for his operations ...

Marita: And the designer has to do it for his job ...

Walter: And his office. If you look at it in this way, the essential point is that there are certain well instituted links which can make those things converge towards a common goal. And it is the legal system and the market which force people together in the same direction. In other words, the client can only force the contractor to assure or to give him what he wants by taking care of quality assurance himself and by making use of the existing institutions of our legal system and the market place.

Marita: I think we could very well exchange the notion "quality assurance" with "progressive management" of complex processes.

Jörg: It's not progressive management, it's a different way of thinking. I believe - and that was also the outcome of the IABSE Workshop at Rigi, Switzerland in 1983 - that the notion "quality assurance" 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 ...

Marita: O.K., it's more than management; What about: "the conscious application of decision theory principles in our professional activities"?

Walter: It's neither management nor decision theory. The issue is that we have decided to focus on a system which is specific to our civil engineering profession. We look to our field and regret that things are not rationally done...

Marita: Then I regret that we took the new notion to describe only a consistent reflection on our professional responsibilities.

Walter: It has a lot to do with professional ethics and with the fact that we as professionals have to care about the built environment from perception to final execution. The word quality assurance was strange to me from the first time I heard it.

Marita: You think, it's just plain "civil engineering" in the very original sense?

Jörg: It's not only the civil engineering profession that is involved. Maybe we end up with saying: quality assurance is "common sense".

Walter: Civil engineering common sense which is not so common after all.

That was the recorded discussion. In reviewing our dialogue, we only shortened the text and modified statements in an editorial manner to be readable. It is obvious, that some statements were primarily intended to stimulate our dialogue and the discussions to take place at Tokyo, rather than to give working definitions of concepts or notions: Hence, we may have not quite fulfilled our task with regard to presenting a comprehensive and consistent coverage of all essential aspects and notions, for example

- tools for decision making including probabilistic methods
- the role of structural design
- trade-off between structural dimensions and quality control
- causes of and losses from structural damage
- human error

are issues which are not raised herein but definitely deserve attention. We hope that these issues as well as all those aspects which are outlined in only a very rough manner are reflected in more detail and with more competence in the following reports.

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