Day 2

Part 2

Quality Assurance in the Design Process

Trends and Incidents

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1. WHAT IS NEW IN THE QUALITY APPROACH

Although Quality Assurance in manufacturing and construction has been explicitly introduced, Quality Assurance in the design process is practised far less.
The reason is quite clear. Design work is generally looked at as code checking which is thoroughly performed by building authorities, certifying bodies or consultants asked to perform such a code check.
In Germany special institutes such as "Prüfer" and "Gutachter" have been established. Quality is in fact traditionally established by code-checking done by third parties.

This is, however, not the aim of modern Quality Assurance systems as intended by the ISO 9000 code. This approach deals with the quality of the total process of design, which in fact leads to more or less effective designs, both still according to the code.
This chapter explains about the basic characteristics from which people perform a design task and it explains about the different tasks and processes required in a quality assured design process.
These paragraphs are checked against the accident with the Sleipner platform in 1991 in Norway, in order to show that a sound quality system can prevent such disasters.

2. WHAT CHARACTERISTICS ARE REQUIRED FROM DESIGNERS; FROM GOOD OR WRONG TO BETTER OR WORSE

Any designer starting in a design team has some basic training. During their training at the university the first objective was to achieve that the students obtained a certain **understanding** of the basic principles of the domain of the subject being taught. It was further envisaged to transfer a certain amount of formal **knowledge** towards the students. Having achieved these two points, the student was trained to use these in order to solve problems, which in fact trained him in **abilities** within the domain he was trained in. In some cases it might even have been possible to appeal to the awareness of the student in order to train him to develop a certain **attitude** in approaching certain problems to be solved when he is confronted with them.

The amount of attention to be paid to understanding, knowledge, abilities and attitude individually is however a matter of constant conflict, as the sources of development of these elements of training objective constantly develop.

Understanding in for instance material behaviour is permanently influenced by **research** in materials all over the world.
This constant change in findings from material research, affects for instance the understanding of the **behaviour** of structural components. This, in turn, effects the development and presentation of **rules and codes** on a national and international basis, such as in Europe for instance the move from national codes to the Structural Eurocodes.

Some understanding of material behaviour, component behaviour and of the interaction between components has to be present, as well as the knowledge of rules in order to design a structure. This means that in this case the design process may only be a trial and error exercise of randomly checking generated structures on codes.

When a formal design process is developed, code checking a design can be anticipated to be successful. The **design process** is then not trial and error, but a cyclic process of **material selection, shaping and sizing**. In order to perform this properly, the **objective** of the whole process has to be clear, meaning that questions such as "should the lowest price for construction be achieved, or the lowest integral price for construction and maintenance?", should be asked. Other questions may also arise, such as "should the structure with the lowest risk of budget exceeding be designed, or the structure with the lowest impact on the environment?". It is really a matter of attitude whether designers approach their task in such a way, instead of merely concentrating on the smallest amount of quantities.

Viewing the world of primary and secondary education this way, it should be clear that a textbook on research and material behaviour is structured differently from a textbook on design. The same is true for the structure of codes. Codes are basically there to check structures already designed and detailed, meaning that shape, material behaviour and sizing have been fixed before the code is used.

During the design process, where shape, material and sizes are fixed, codes are only used in the sense that the design process anticipates later code checking. This means that documentation and accuracy of the initial design process can be less severe and is differently structured. Consequently, decisions in the initial design process are taken with a relatively high degree of uncertainty.

During code checking however, the application of rules and codes, using the knowledge and the abilities taught during training, is a process that can only be right or wrong. Of course this is only right in principle, as codes can sometimes be interpreted differently. Apart from that, structures can be out of range of anticipated objects for which the code has been made.
Whether a designer creates a more effective structure due to a better understanding of the material and uses an attitude in which he follows a good structured design process, anticipating the objective of the design question he is solving, is not a matter of true or false. This is a question of better or worse; of more or less effective, as illustrated in figure 1.

The consciously structured approach of a design question is a matter of quality. This means that attention for quality has to be present always in excess of specifications. Awareness of quality during the execution of a process prevents errors in specifying and presents better products with less effort.

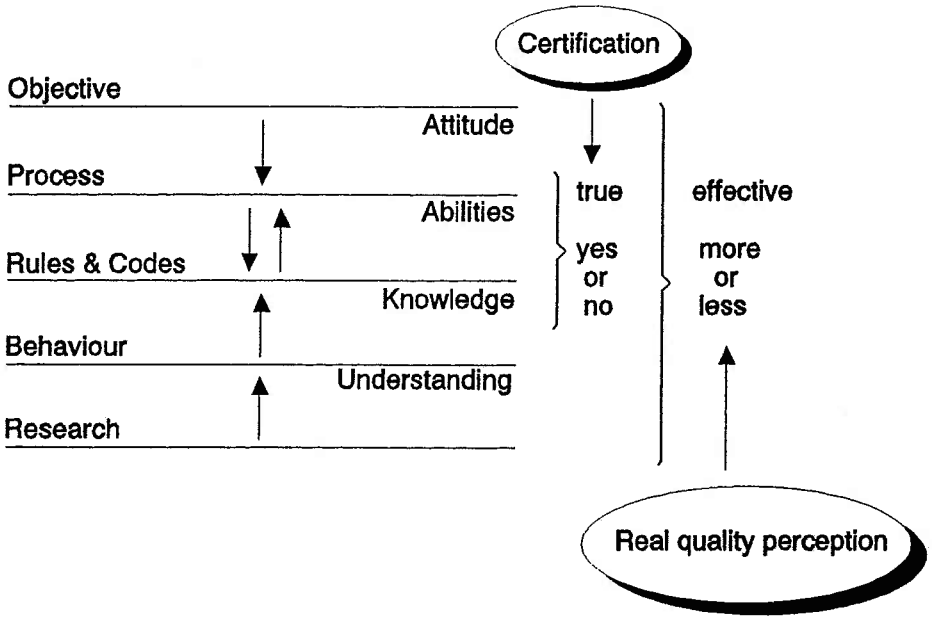

Fig. 1 Sources and their learning objectives

Another important reason not to use routine only, is the fact that everything changes, quite obviously in an accelerated way. Looking again to the objectives of the learning process and the underlying means, some examples of these changes can be given.

Changes in	learning and society affecting the design	
Objective	Environmental considerations Speed Request for integral approach Attention for labour conditions	
	Demand for quality assurance	**Attitude**
Process	Larger and more sophisticated computer programs	
	Less available experience Less technical feeling	**Abilities**
Rules & Codes	Ever thicker; Penetrating in everything International Codes (Eurocodes)	
	Ever harder to know everything required Experiments with databanks and AI systems	**Knowledge**
Behaviour	New materials New production techniques giving new details and shape	
	More difficult, because of attention for more aspects	**Understanding**
Research	More and Deeper Individually more narrow	

3. THE BASIC ELEMENTS IN AN INTEGRATED PROCESS: PROJECT CHARACTERISTICS, CONTROL SYSTEMS, METHODOLOGY OF THE PROCESS AND SUPPORTING SYSTEMS

3.1 Design and construction, different from manufacturing

This chapter deals with the basic elements that are present in every design, design-construct or engineer-procure-construct-install (EPCI-Contract) job. It should be clear that not just the structural design or the structural analysis is part of this process. It involves the whole design in view of construction schedule, costs, technical possibilities and potential risks.

It should be realized that this is a process of generating and communicating information, of applying the right knowledge, of making decisions and of documenting. This process takes place within an organisation consisting of human beings, where every participant is supposed to have his own role. The process can be supported by all kinds of means facilitating communication such as telephone, fax, PC and CAD networks, PDI, EDI etc.

The process sketched above also involves planning of construction method and schedule. In the construction industry this is usually organized differently. Quite often the design is done by one party, the consultant and the architect, whereas construction is done by the contractor, conform drawings and specifications received in the tender documents. In the motorcar industry, design and preparation of construction is just one thing, carried out in one organisation, taking into account costs, technical possibilities of robots, materials and other aspects required for manufacturing.

The construction process itself is mainly a logistic process, meaning that the presence of sufficient construction materials, workers and equipment in the right place at the right moment is crucial for the actual construction. Of course information is important, but it is generally supposed to be present, supplied by a third party such as the consultant. Otherwise construction is supposedly impossible.

In view of the consequences of the characteristic difference in the organisation and control of design and construction, it is clear that in case resources are present, the construction process can be easily accelerated by merely increasing the supply of resources, whereas the design process requires a complete rethinking of the methodology before acceleration can actually take place.

Consequently, to illustrate the statements mentioned above one could say, "it is possible to build a house in one day, but it is impossible to plan to build a house in one day", the reason being that the actual construction is a logistic process and the planning of the method and schedule of construction is an information process requiring a specifically selected sequence of execution to deal with complexity, uncertainty and the hierarchy of all people involved.