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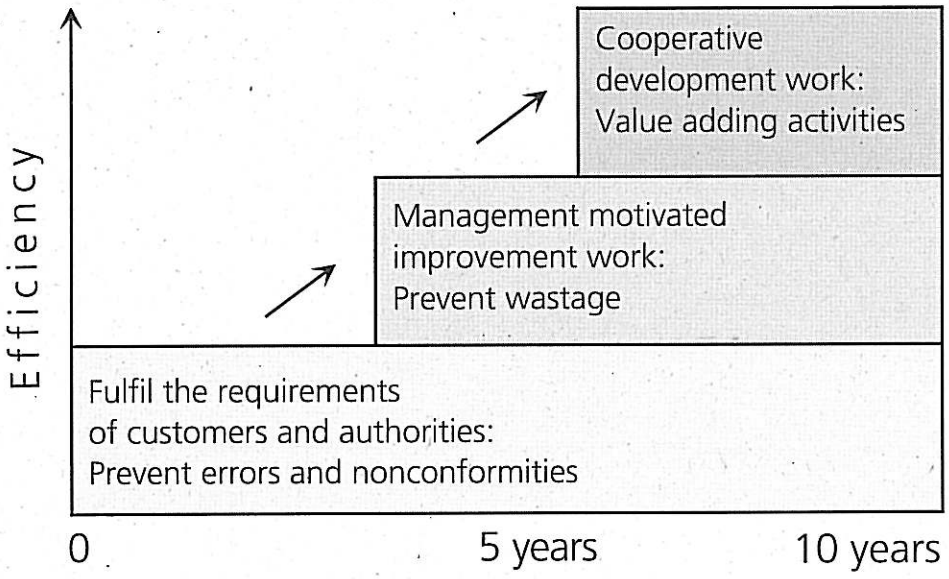
Norwegian Building Research Institute

Odd Sjøholt

From Quality Assurance to Improvement Management



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Preface

Behind this report is a Nordic group consisting of eleven contractors, and three research institutes and universities. Since 1991, the group has been exchanging their experiences with total quality management under the title "Total Quality Management the Nordic Way - TQMNW". The predominant objective of the project is to strengthen the Nordic Construction Industry's ability to compete in the international market.

From Finland:	Puolimatka Oy, Skanska Oy, YIT Corporation and Technical Research Centre of Finland - VTT
From Norway:	Byggholt a.s., Norwegian Contractors a.s., A/S Veidekke and The Norwegian Building Research Institute (NBI)
From Sweden:	F O Peterson & Söner Byggnads AB, JM Byggnads och Fastighets AB, NCC AB, Siab AB, Skanska AB and Chalmers University of Technology.

As a result of phase I, 1992-93, the group published the report "Measuring the results of quality improvement work" (🕮 1). In phase II, 1994-95, the group has chosen three subjects related to TQM, and discussed these in smaller work groups, and at several conferences:

1) The path from quality assurance in accordance with ISO-standards to total quality management (TQM).
2) Benchmarking, systematic company comparisons
3) Measurement of customer satisfaction.

This final report presents the results of the first topic, the path from quality assurance in accordance with ISO-standards to total quality management. The participants in the work group from the companies have been Thorbjørn K. Sand, Norwegian Contractors, Nils Öhrström, Skanska and Lars Skålnes, Veidekke. Odd Sjøholt from NBI has collected the material and, through group discussions and individual comments, worked it into this report, and stands responsible as its author.

The present paper strives in showing how quality focused improvement work can be built up little by little, from simple preparations to more thorough and strategic innovations. Below, we describe the ISO-standards, and the words and expressions that deal with the concept of Total Quality Management. At the same time, we outline recommendations for ways in which builders and contractors can exploit available standards, guidelines, techniques and written aids. Above all, this report is intended to be of use for companies and others within the construction sector in their evaluation on how to deal with demands and regulations regarding quality, and how to draw up a long term plan for their improvement work.

Oslo, October 1995
Norwegian Building Research Institute
Åge Hallquist
Managing Director

Contents

Summary

Background

The Group TQMNW consists of contractors accounting for many years of experience and knowledge in development and improvement of their own organisation, management and control. The motivating power, and the concepts have changed through time, often in the wake of what has happened in other industries. Examples are rationalisation (work studies, time losses analyses, process studies), production planning and control (processes, time, resources), organisational development (strategy, goal setting, goal control, responsibility and authority assignment, functional analysis), material control (logistics), time focused management, etc.

During the past 5-10 years, contracting companies have been through one or several phases operating with different concepts connected to the word "quality". Terms with the prefix "Quality" often deal with a new side of a known management concept, and this has resulted in existing methods being reviewed from new angles.

With this background, the contractor companies wished to clarify the connection between the various developmental directions linked to quality. They also wished to elucidate the definition of TQM (Total Quality Management) according to international quality standards.

Conclusions

Customer motivated development of the sector's management systems

A customer motivated emphasis of ISO standards on Quality Assurance has contributed to a systematic effort within the building and construction sector to prevent errors and nonconformities. Many have begun to alter their focus to the customer's requirements and expectations. This is a first step in a long term improvement process. The sector still has a good deal to learn within this topic. Certification of the Quality System is a possible aid to this, although many are sceptical of its actual value. How long the new terms beginning with the words "quality", "safety" and "environment" will last is another disputable topic. For example, the term "Quality Plan" will be less used in the future as a governing principle, and instead will be integrated in a Project Management Plan.

Management conducted improvement work- the next step in the development

An integrated managerial development built on ISO-standards for Quality Management raises the organisation's objectives to a more thorough level and a continuous improvement process that engages all business activities within the company. The ISO-standards for Quality Improvement, where all non-value adding activities, and all forms of wastage are weeded out, go even further in the direction of practical guidelines.

Several guidelines have been worked out to aid such work, among them Juran, Deming, and the Five-Step Model that is introduced to the Construction sector in Norway, Sweden, Finland, Iceland and Holland, among others.

The critical factor in the Construction sector is the average manager's knowledge and understanding of how he can organise and run this internal improvement process. There is therefore, altogether in this sector, an enormous potential for improvement.

On behold of today's trend of focusing on the concept of *Quality Improvement*, this will also change with time to an emphasis on general improvement measures where quality, safety and environment are inevitable elements.

Co-operation motivated development - for the more advanced

One way of pursuing the improvement process is to review strategy, and to encourage totally renewed thinking. Only by such methods can one achieve a leap in the improvement of efficiency. Organised co-operation between various types of involved parties is one element in such a development process, where, for example, a contractor will establish closer connections with his most important suppliers. A more comprehensive and innovative use of information technology is another example.

Measurements and analysis will still form the basis for decisions. Companies make use of various different indicators for performance. Methods of measuring the TQM level of a company have also been developed, such as a point score system linked to quality awards. The Nordic contractors' group has tested and adapted such a system for use in companies and building projects. But as time passes by, the concept of Total Quality Management will also lose its novelty value, and its contents will be absorbed as an important part in the company's general endeavours to achieve improvement in organisation, management and control.

New techniques and concepts are continuously being introduced for the Construction sector as well. Benchmarking, Business Process Re-engineering and Partnering are examples of this. The Construction sector must itself choose from the selection of offers that arise. Several companies within the TQMNW group have already documented useful results from the practical adaptation of new techniques and written aids. But still, the moving of borders will continue to embrace a limited group of advanced companies within the Construction sector.

1. Management and control in the Construction sector - the influence of the ISO-standards

Since the 1980s, Quality Standards have included requirements and guidelines for management and control. The first editions have been updated in the 1990s. The standards are to have general application, but are designed in such a way that the various sectors should not need their own variations. In addition to updating one has made a whole new set of guidelines for practical use on, for example, quality improvement. A draft issue also exists for standards for environmental management. Requirements dealing with health and safety are mostly to be found in the authorities' regulations.

Below we quote the most relevant standards, with the ISO number as reference. *Fig. 1* shows the relationship between the standards and their practical application.

ISO 8402:1994. Quality management and quality assurance. Vocabulary.

Larger contents makes it considerably better than the previous version from 1986. The introduction explains in a lucid fashion the connection between many words and concepts.

ISO 9000-1:1994. Quality management and quality assurance standards. Part 1: Guidelines for selection and use.

This is a considerable improvement on the previous edition from 1987. It explains the principles behind the renewal of the ISO-9000 series. Under the sixth clause, it explains that a supplier may use the ISO-series in two ways: *management motivated*, and *stakeholder motivated.* In many countries the interested parties, (the customers and the authorities) have been the most usual motivating power behind a supplier's efforts, based on the ISO 9001-03. The greatest innovation in the 9000 series is that several new aids are created for management-motivated quality work in the 9004 series. Another innovation is the categorisation of the concept of products so that all types of industry or business can accept the basic standards without having to adapt them. The products are divided into "hardware, processed materials, software and service".

ISO 9000-2:1993. Quality management and quality assurance standards. Part 2: Generic guidelines for the application of ISO 9001, ISO 9002 and ISO 9003.

These standards first and foremost apply to customer-motivated quality work.

ISO 9000-3:1992. Quality management and quality assurance standards. Part 3: Guidelines for the application of ISO to the development, supply and maintenance of software.

Programmes developed in relation to the customers' specifications are covered here. There is a cross reference to ISO 9001. For the Construction sector this can apply, among other things, to programmes for calculations, analyses and drawings.

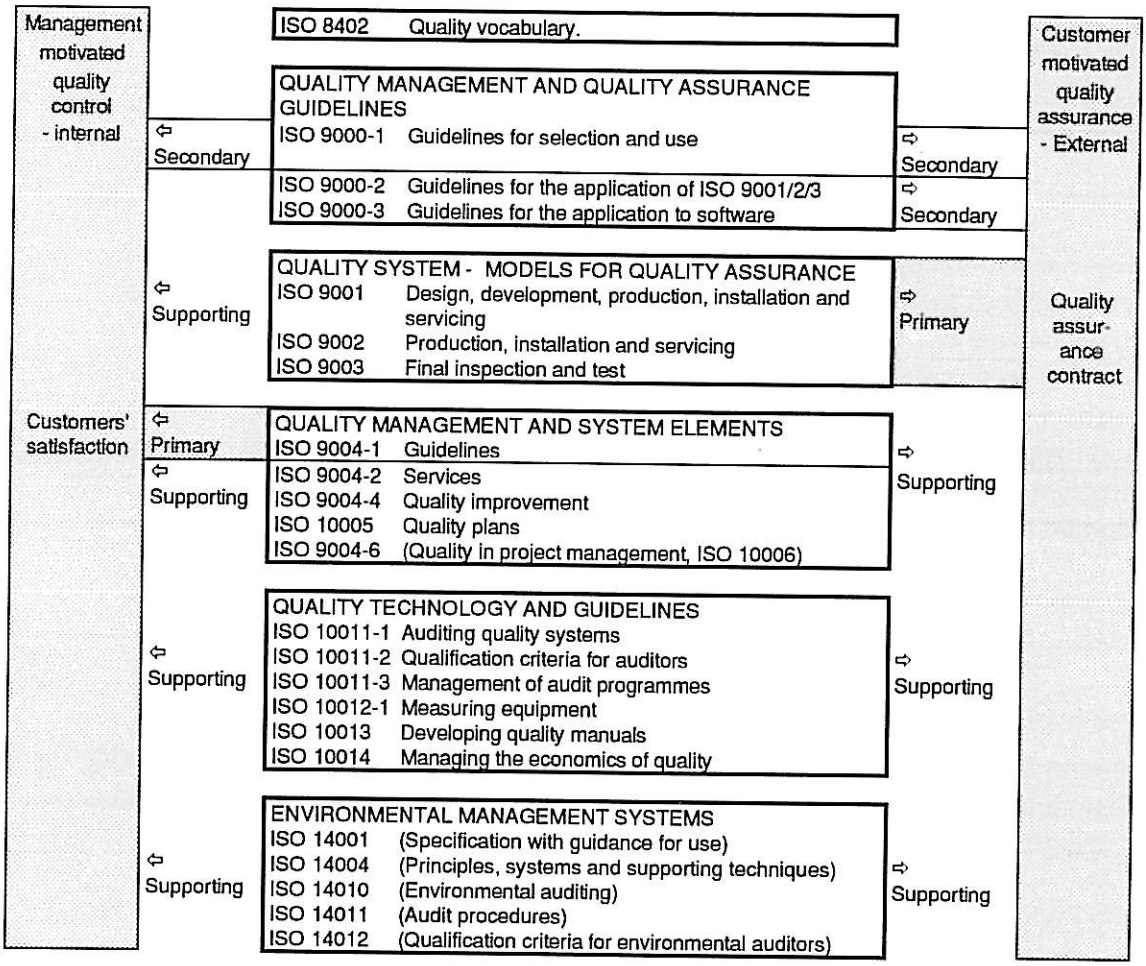

Fig. 1. Quality standards within the ISO-series, existing and under development, and how they can be applied to customer motivated quality assurance and management motivated quality control. The central column shows which standards exist, and which (in brackets) are under development.

Arrows that point right show which standards are used mainly for external quality assurance, that is for the customers in a contractual context. The most important standards are marked "primary", the next most important are marked "secondary", while others, that would mostly be used as a basis, are marked "supporting".

Arrows that point left show correspondingly which standards are used mainly for internal quality management.

ISO 9001:1994. Quality systems - Model for quality assurance in design, development, production, installation and servicing.

A change from the previous edition is that *all* definitions in ISO 8402 are to apply.

ISO 9002:1994. Quality systems - Model for quality assurance in production, installation and servicing.

A practical innovation is that the chapter numbering system is like that of ISO 9001, therefore a blank chapter has been included under "design control".

ISO 9003:1994. Quality systems - Model for quality assurance in final inspection and test.

ISO 9004-1:1994. Quality management and quality system elements: part 1: guidelines.

There are not many changes in relation to the previous version 9004: 1987. A new model looks at all activities as processes with *inputs* and *outputs*. This standard aimes aimed more at the total management of the company than 9001/2/3 themselves. It builds upon the same product/process principles as 9001, but does not entirely cover the concept of TQM.

ISO 9004-2:1994. Quality management and quality system elements. Part 2: Guidelines for services.

"Services" here cover processes where the customer is in close contact with whoever renders the service: hairdresser, restaurant, etc. In the building process it is the architects and engineering consultants that are the most likely to use this standard.

ISO 9004-4:1994. Quality management and quality system elements. Part 4: Guidelines for quality improvement.

This is a new standard. It brings in many of the elements from TQM and is an important addition to the 9000-series. It describes continuous improvement as a company work style. Its appendix describes the most frequently used aid for collecting data and analysing the progress of the process "Check-Act". No corresponding aid for "Plan-Do" is mentioned. All companies that are working for "Total Quality Management" should build on this standard.

ISO 10005:1995. Quality management. Guidelines for quality plans.

Quality plans should describe the execution of individual projects, and are therefore particularly relevant to the building industry. The standards deal with the same 20 requirement elements as ISO 9001. It emphasises that a quality plan may be simplified by basing it on the company's existing quality system. Furthermore, the structure and coding system can be chosen freely and independently from the structure given in the standard. As an appendix, some simple examples of quality plans are described.

ISO 9004-6:1994. Quality management and quality system elements. Part 6: Guidelines for quality in project management. CD (Committee Draft).

The content is most useful for the construction sector. A project adapted system structure is suggested which also match with the building process. See later discussion in connection with *Fig. 5*.

ISO 10011-1:1992. Guidelines for auditing quality systems. Part 1: Auditing.

Part 1 describes a method for the auditing of quality systems, as a basis for a company's activities in accordance with the intentions of the ISO 9000-series.

ISO 10011-2:1992. Guidelines for auditing quality systems. Part 2: Qualification criteria for quality systems auditors.

ISO 10011-3:1992. Guidelines for auditing quality systems. Part 3: Management of audit programmes.

ISO 10012-1:1990. Quality assurance requirements for measuring equipment - Part 1: Management of measuring equipment. DIS (Draft).

ISO 10013:1993. Guidelines for developing quality manuals. DIS (Draft).

A quality manual presents the quality policy of a company and describes its quality system. The standard gives guidelines for the content of a quality manual, and how it may be designed, published and maintained.

ISO 10014:1995. Guidelines for managing the economics of quality. CD (Committee Draft).

This standard includes useful analytical methods for the improvement of economics and customers' satisfaction. Together with ISO 9004-4 it gives a very good basis for improvement work.

ISO 14001:1995. Environmental Management Systems - Specification with guidance for use. DIS (Draft).

This standard is one of five new drafts for standards of environmental management, the ISO 14000-series. The principles are the same as those used in the ISO 9001, and the requirements in the standards can easily be integrated in a quality system that fulfils the ISO 9001. The practical content must cover those parts that are relevant for the company, - see sample application areas on Policy for Environmental Management in *Fig. 2.*

Policy for Environmental Management - areas of application
1 Reduce waste and resource consumption (materials, fuels, and energy)
2 Reduce or eliminate emission of harmful or poisonous substances to the environment.
3 Design products with an eye to minimal negative environmental impact from production, use and disposal.
4 Control environmental impact of extraction/production of raw materials (e.g. on nature as our life base, on the diversity of species, and on aesthetic values).
5 Minimise adverse environmental impact of new development by strategic planning.
6 Work towards a sustainable development.

Fig. 2. Example of areas of application for environmental management. The individual company must develop its own policy for environmental management so that it covers the areas relevant for its own work.

All the quality standards have this in common: they describe what requirements should be met, but *not how the company or organisation should act to move from its "actual situation" to a "desired situation"*. The greatest challenge lies in the internal process for developing and implementing new and better solutions. ISO 9004-4 Quality Improvement describes, in Chapter 6, some elements in the improvement process, with examples of how such changes can be achieved, but does not approach a complete recipe.

2. Concepts for management and control - ISO Standards' duplication

Background

This chapter gives a summary of the most important and most used terms for management and control of construction companies and projects, where these apply to "quality". The introduction and use of terms with the prefixed word "quality" have become more and more usual in the last 10 years. These terms duplicate earlier terms applied to management and control.

The dissemination of these terms as active concepts is also discussed, together with those factors that influence the development of these concepts, and the Construction sector needs for the future. On the basis of this background, recommendations are made for the use of these concepts in the short and long term context. The text assumes that the reader is familiar with the words and expressions used in connection with "quality".

The object of a defined term, or "concept" is to simplify and ensure correct communication, by the description (definition) of important factors and by the choice of set words for the concept. But all this only has any worth when a term describing a concept is interpreted alike by all its users in practice. Therefore, understanding, acceptance and learning are important.

The word "quality" is used in daily speech, and in advertisements, to describe products of high standard. The ISO-standards are built on a philological meaning of the word "quality", and apply to "the totality of characteristics of a product that bear on its ability to satisfy stated or implied needs".

The terms for management are often used in varying combinations, both for the company as a whole and for the individual project. After these, it comes the combinations with the word "quality". And after these again, the combinations with the words "safety" or "environment". These constitute a good many terms altogether. Similarities in terminology and lack of clarification often result in a situation where many members of the Construction sector cannot tell the terms apart. One of the reasons is that "quality" in its "new" standardised meaning is rather unfamiliar for most, and it is necessary to educate. It can take a long time to achieve a uniform understanding throughout the Construction sector.

Synopsis of terms that describe concepts with reference to standards

Selected terms for management, control and quality are listed in *Table 1*.

Table 1. Terms for management. Since quality terms are based on international standards, we give both the Norwegian and the English terms for the basic concepts. At the same time, those terms starting with the prefix "Quality" ("Kvalitet" in Norwegian) are marked with "Q" ("K"). For each term, reference is given to any definition or use in the quality standards..

The terms are sorted into four groups, according to whether they apply to:
1 Concepts that deal with management and control
2 Concepts that deal with processes and its sub-division, project levels, etc.
3 Concepts that deal with customer/supplier relationships, contracting parties, etc.
4 Concepts that deal with documents, and the documentation of points 1-3.

K	Norwegian concept, basis (with "Kvalitet = K" where relev.)	Q	English concept , basis (with "Quality = Q" where relevant)	ISO 8402	ISO 10005
	1 Ledelse, styring		**Management, planning/monitoring/control**		
K	Ledelse	Q	management	3.2	
	Prosjektledelse		Project management		3.4
	Myndighet		Authority		
	Ansvar		Responsibility		
	Funksjon		Function		
K	Politikk	Q	policy	3.1	
K	Mål	Q	objectives		4.1
	Mål for prosjekt		Project objectives		3.2
K	Krav	Q	Requirements for quality	2.3	
K	Styringssløyfe, regulering	Q	loop, spiral, (cybernetics)	4.2	
	Demingsirkel (flere navn)		Deming cycle (other names, PDCA)		
K	Styring	Q	control	3.4	
K	Planlegging	Q	planning	3.3	
K	Sikring	Q	assurance	3.5	
	Internkontroll (Norsk lov; §3)		Internal control		
K	Revisjon	Q	audit	4.9	
	Inspeksjon		Inspection	2.15	
	Egenkontroll		Self-inspection (by the performer)	2.16	
	Testing, prøving		Testing		
	Avvik		Nonconformity	2.10	
	Korrigerende tiltak		Corrective action	4.14	
	Forebyggende tiltak		Preventive action	4.13	
K	Forbedring	Q	improvement	3.8	
	Total kvalitetsledelse		Total Quality Management	3.7	
	2 Prosesser, elementer i disse		**Processes, process elements**		
	Prosjekt		Project; 9004-6, 3.1		3.2
	Kontrakt		Contract		3.1
	Kvalitet		Quality	2.1	
	Tid		Time		
	Økonomi		Economy		
K	Kvalitetsrelaterte kostnader	Q	Quality-related costs	4.2	
K	Tap	Q	losses	3.4	
	Produkt		Product (hardware, software, processed materials, services)	1.4	
	Prosess		Process	1.2	
	Faser		Phases		
	Trinn		Stages (ex. design, purchasing, production)		4.1

K	Norwegian concept, basis (with "Kvalitet = K" where relev.)	Q	English concept , basis (with "Quality = Q" where relevant)	ISO 8402	ISO 10005
K	Kvalitetssystem bygg og anlegg Faser og styring, Arkivnøkkel	Q	Quality Management System, Phases and control, Archive codes		
K	Aktivitet	Q	activity		4.1
	Verdikjede, leverandørkjede		Supply chain; 9004-4, 3.2		
	Grensesnitt		Interface		
	Kommunikasjon		Communication		
	Informasjon		Information		
	Konflikt		Conflict		
	Integrering		Integration		
	Intern		Internal		
	Ekstern		External		

3	**Kunde/leverandør, kontrakts-parter, organisasjonsenheter**		**Customer/supplier, contracting parties, organisational entities**		
	Bedrift eller firma, institusjon		Company	-	
	Organisasjon (med egne funksjoner og organisasjon)		Organisation	1.7	
	Basis-organisasjon		Originating organisation, 9004-6, 4.2		
	Enhet (produkt, aktivitet, prosess, organisasjon, person)		Entity (product, activity, process, organisation, person)	1.1	
	Gruppe		Team		
	Interessepart		Stakeholder; 9000-1, 3.5 (9004-6, 3.6)		
	Kunde		Commissioner (client is not defined)	1.9	
	Eier (byggherre)		Owner		
	Bruker (beboer)		User, (Occupant for buildings)		
	(Kjøper)		(Purchaser)	1.11	
	Leverandør		Supplier	1.10	
	(Kontraktør, entreprenør)		(Contractor)	1.12	
	Under-entreprenør, under-levr.		Sub-contractor, sub-supplier	1.13	

4	**Dokumenter, dokumentasjon**		**Documents**		
K	System	Q	system	3.6	
K	Håndbok (Eks. Bedrifts-, personal-)	Q	manual	3.12	
K	Systembeskrivelse	Q	system description; 10011-1, 5.1.3		
	Rutiner, prosedyrer		Procedures	1.3	
K	Program, handlingsplan	Q	programme, EOQ glossary 1989: 1.1.11 A set of activities, resources and events serving to implement the quality system of an organization.		
K	Forbedringsplan	Q	improvement plan; 9004-4, 5.2		
K	Plan	Q	plan; 9004-1, 5.3.3, 9004-6, 5.2.2	3.13	5
	Prosjekt-plan		Project plan 9004-6, 3.5		4.1
	Inspeksjonsplan, kontrollplan		Inspection plan		4.1
	Prøveplan		Testing plan		4.1
	Budsjett, regnskap		Budget, cost control		
	Tidplan, fremdriftsplan, rapport		Time schedule, report		
	Ressursplan, rapport		Plan for resource, report		

Explanation of above tables:

Norwegian concept terms, basic, *includes terms that have meaning beyond the context of quality.*
English concept terms *are translations of the Norwegian terms..*
K and Q *show that the concept is defined in the standards with the prefix "quality". (kvalitet).*
ISO 8402 *refers to vocabulary definitions.*
ISO 10005 *refers to the section in Guidelines for quality plans.*
In addition, the English column contains references to other standards.

Many of the new terms for Environmental Management are built on the same terminology as for quality, see Table 2. The Table shows several basic terms that are defined with significance for both quality and environmental management. The parallel definitions are not identical linguistically, but the content is mostly similar.

Table 2: Concepts for Environmental management.

M	Norwegian concept, basis (with "Miljøledelse = M" where relevant)	EM	English concept, basis (with "Environmental Management = EM" prefixed where relevant)	ISO 8402	ISO 14001
M	Politikk	EM	policy	3.1	3.9
M	Mål *)	EM	objectives		3.7
M	Måltall *)	EM	target		3.10
	Organisasjon		Organisation	1.7	3.12
	Interessepart		Stakeholder; 9000-1, 3.5		
	Interessepart, berørt part *)		Interested party		3.11
M	System	EM	system	3.6	3.5
M	System revisjon	EM	system audit	4.9	3.6
M	Program, handlingsplan *)	EM	programme		4.2.4

Explanation of above tables:

Norwegian concept terms, basic, *includes terms that have meaning beyond the context of environment. Those marked with * are unofficially translated from the draft for environmental standards.*

English concept terms *correspond to the Norwegian terms..*

M and EM *show that the concept is defined in the standards with the prefix "environmental management" - EM in ISO 14001 (📖 2).*

ISO 8402 *refers to vocabulary definitions for quality terms.*

Background for the various types of concepts

1 Management and control concepts

These concepts arise from the theory of organisation and management. This theory was developed in various professional disciplines, mainly on a humanistic basis. The technocrats that dominate the Construction sector have only modest training in the subject. Project management as a topic is given poor coverage in engineering education, while nearly all activity within the Construction sector is project orientated. "Quality" is linked with management and control, and the techniques that deal with them. This is demonstrated by the above table where most of the concepts with the "quality" prefix are to be found under management and control.

2 Process Concepts

The concepts that deal with processes have been developed particularly in connection with product development and presentation. As far as production techniques were concerned, this included control of resources, time and economy. It has also included various forms of rationalisation (time losses, work simplification, etc.) Here quality is integrated with the focus on the customer's needs or requirements, together with society's requirements. The rationalisation techniques are focused on prevention of nonconformities in product or process, on avoidance of waste and wastage along the

way, and on the removal of all non-value-adding activities. "Quality costs" were renamed at an early stage to "Non-quality costs", and we have developed a series of concepts around the costs of errors and nonconformities. The analysis of improvements requires categorising costs in various ways, depending on whether one is referring to process, use of resources or results.

In one draft standard (🕮 3), the costs are described from a process model, with a clarification of input and output (results), which resources are used, and what form of management is employed (*Fig. 3*). The activities in the course of the process, the results, and the people/positions involved are described. Thereafter, the cost of the process is calculated, under the assumption that it progresses as planned, and without errors. This method gives a minimum cost. The next step is to analyse the process to find all the weak points, and to reduce wastage.

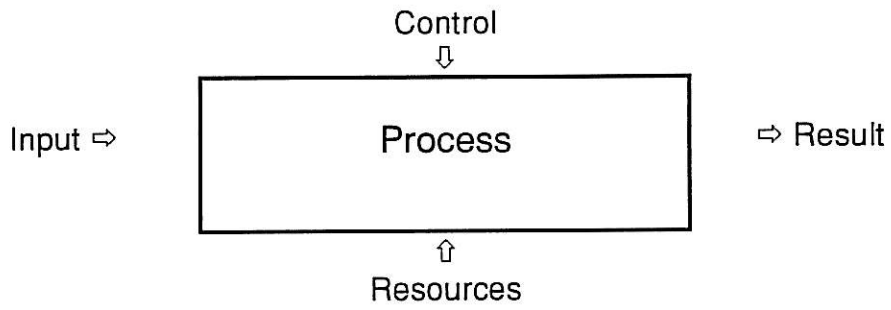

Fig. 3. It is necessary to analyse processes and activities in order to work out improvement activities (🕮 3). This is also dealt with in (🕮 1, p. 11)

The activities throughout the various phases of the building process have to be planned and supervised. An important contribution to better communication is a model based on a common structure for both the company and the project organisation: The *Quality Management System* (🕮 4, p. 82), see *Fig. 4*. This system covers all forms of management and monitoring of all parties involved in the building process, both on the company and on the project level. The main divisions, or "Chapters" follow the building process, and covers the entire lifecycle of a building. The subdivisions follow aspects of management linked to the so-called Deming Cycle: plan, do, check and act. These activities apply to everything: from quality, time and economy to internal management of health, environment and safety, and the company's self inspection of its fulfilment on building laws and regulations. This system has been tried out by authorities, customers, consultants, contractors, sub-contractors and manufacturers both in various countries.

A parallel solution to the *Quality Management System* is suggested in the draft version for the standard "Quality in project management" (🕮 5, table 2), see *Fig. 5*.

3 Commissioner and supplier concepts

The concepts dealing with customer and supplier as contracting parties has its juridical roots based on contract standards. The Construction sector in Norway is relatively orderly here. The assignment of responsibility and tasks within building projects varies enormously however, and the diversity of contract forms makes the clarification of interfaces between parties of critical importance. Up to now, formulations of "quality" have not been included in contract standards. But in the contracts for individual projects requirements for documented evidence related to quality often arise.

A common division for all construction management systems								
	Company	Project/ building process ⇨						
Main division ⇨ Sub-division ⇩	1 Univer-sal	2 Acquisi-tion Initiation	3 Program-ming	4 Design	5 Prepar-ation	6 Produc-tion	7 Delivery	8 Facilities Manage-ment
1 Organisation								
2 Communication								
3 Requirements								
4 Resources								
5 Purchasing								
6 Scheduling								
7 Economy								
8 Execution								
9 Experiences, improvements								

Fig. 4. Subdivision of management and control systems that can be used for the entire building process and for all types of construction companies. A common system such as this can contribute to better co-ordination.

Management elements involved in all phases of a project				
Main divisions, phases of a project ⇨ ⇩ *Sub-divisions*	2 Conception	3+4 Develop-ment	5+6 Realisation	7 Termination
0 Strategic project processes				
Operational project process related to:				
1 Organisation				
2 Communication, co-ordination				
3 Scope (task, control), risks				
4 Resources				
5 Procurement				
6 Time (schedules, interrelationships)				
7 Cost				
8 Product				
- Supporting processes				

Fig. 5. The draft for the ISO standard for project management (📖 5, table 2), presents a system of common management elements (sub-divisions) for management of each phase (main divisions). The numbering is not included in the standard draft, it is added here to show the similarity between this and Fig. 4. The main difference is that Fig. 4 has a separate chapter dealing with topics that are common to all phases, and the company in its entirety, while this is a continually repeated sub-chapter (supporting processes) in Fig. 5.

The concepts of "customer" and "supplier" are basic to all quality concepts. The supplier must fulfil the customer's needs and requirements. All needs and requirements are transferred downwards through a hierarchy. At the top is the commissioner himself: his contractors are the customers for the next level of suppliers, which again are the customers for the sub-suppliers etc. The quality standard attempts to define a number of concepts here, but they must be adapted to the needs of the Construction sector.

The term stakeholder turns up under Total Quality Management. Emphasis is laid on the fact that one gains most by optimising the profit of all parties. There is good reason to stimulate the use of this idea, in order to clarify customer-supplier relationships at all levels, internal as well as external.

4 Document and documentation concepts

Documents and documentation in this context deals with documents that concern management and control. Therefore, the actual terms used at any one time will reflect the current trends for management and control.

The future choice of concepts for company and project management systems in the Construction sector

Trend concepts

Quality concepts are introduced without their connection or linking to "the rest" being sufficiently clear. For example, what does Quality Management actually mean related to the entire management? What does the Quality Plan mean related to the Project Plan? What does Quality Control mean for the control of the project/company as a whole? In the same way the concept of Internal Control is introduced, for example in the contexts of health, work environment and safety, and Self Inspection for design and production, without these being placed in the context of the total system of control and inspection. A series of standards (ISO 14000) for environmental management is currently under way (🕮 2). Many companies have made their own Quality systems, and thereafter their own Internal control systems, and perhaps Self inspection systems, and Environmental management systems. Some already have their own administrative systems, economy systems, personnel systems, etc. To a certain degree the development can be compared with the fashion world, where the continuous demand to focus on new themes is met by offers of new "systems" from those that market services, a development that may, in its worst form, result in a "King's New Clothes" situation.

Quality Plan - a concept that can confuse

The most problematic term linked to quality is, at the present time, the "Quality Plan". The confusion is partly due to the fact that several parties in the building process are not accustomed in drawing up an administrative plan for the collective management and control of their part of the project (i.e. Project Plan) Secondly, for many the term Quality Plan is synonymous with the documentation of the Quality Assurance of the product, with the appurtenant Inspection Plan. ISO 10005 "Guidelines for Quality Plans" states that the Quality Plan for a contract can normally refer to the existing basic system of the company, but must be adapted to suit the project. Further, it states that the *Quality Plan may be a part of the Project Plan.* This is a practical solution for the Construction sector, since project management is so fundamental. A project plan is defined as follows (🕮 5): "Document setting out the specific practices, resources and sequences of activities required to meet the project objectives". It seems reasonable to choose to draw up project plans that simultaneously fulfil the requirements for a "Quality Plan" (see later discussion on p.41).

Vision

Improving the use of management concepts in the Construction sector as a whole is a slow process, with a great risk that unsuitable solutions will continue to be widespread.

Many companies, among them larger contractors, have developed several subsidiary systems over time, such as construction site management's manuals, quality systems, safety manuals etc. A future co-ordination would demand that the relevant parts of these and any other part-systems are revised for further simplification. On the short term, we must make use of those concepts that are already integrated, and that are already widely used without misunderstandings.

In the long term, a company must base its activities on the basic elements for management and control (policy, organisation, responsibility assignment, requirements etc.), and see how these can fully cover the requirements of quality, safety, work environment and environmental protection. Any company should design its policy to cover all actual objectives and requirements. Furthermore, the description of the organisation should define and delegate responsibility from a collective view point, without separating out quality, environment, etc. from the other aspects. This is a future directed solution, which is flexible enough to cover new needs as they arise.

At present, a common motivating force strong enough to overcome individual interests linked to the various concept areas, seems to be lacking. Therefore, a common strategy for the integration of concepts is of interest to the entire Construction sector. The development can be influenced by the co-operation of companies that set the tone, and that see the advantage of freeing the concepts for management and control from changing trends. One sets and examples for other parties in the sector by, among other methods, participating in larger projects.

One common strategy could be the integration of the objectives and concepts into one corporate system for the entire company and projects, which is simple and flexible enough to cover all the relevant aspects, such as quality, health, environment (both work and natural), safety, etc.

In order to achieve this, the basic concepts must be strengthened and developed. The new "specialised" concepts must be toned down, and be subordinated to the most fundamental concepts. It is important to reduce the discussion on new concepts, and concentrate on the concrete improvement of management and control. Seen rationally, it is easy to show that this would be a desirable development.

3. From Quality Assurance to Total Quality Management - a long way

The development and improvement of organisation and management in the Construction sector pretty well follows the same pattern as in other industries. Integration comes often rather later, and the actual techniques and aids must be adapted to suit the special conditions in the Construction sector (*fig. 6*).

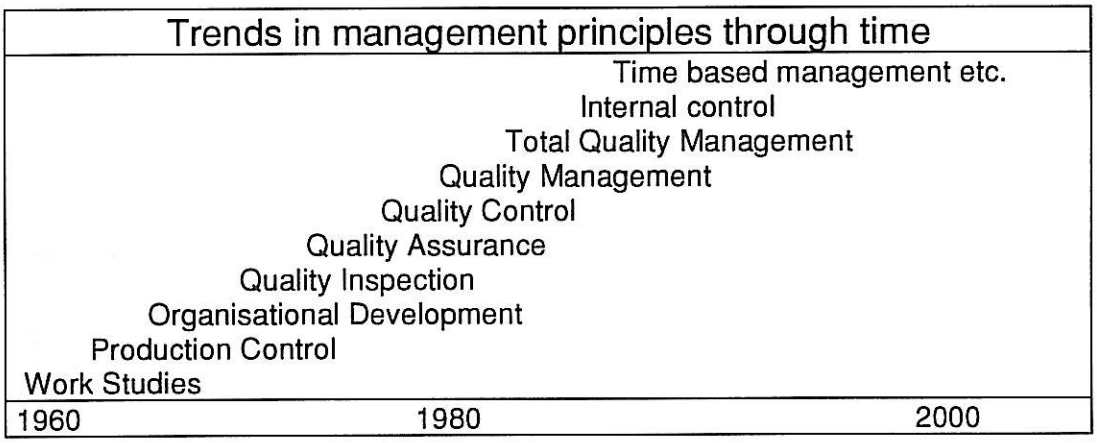

Fig. 6. Concepts for development of management and control change as time goes.

The actual form of leadership in practice is influenced by research and the development of theory. Early in the 1900s, Taylor launched his principles for rational management (🕮 6). Through technological analyses and supervision, the management was to increase the efficiency of the work processes and of production. In the 1920s and 30s theories of leadership were based on a more open relationship with the members of an organisation. In practice one has attempted to exploit the best of both worlds. Formal management systems, and participation in decision making are combined in different ways. Self-managed groups were the reigning "culture" on heavy construction sites in Nordic countries before research and education were directed at democracy. The circumstances and the framework for any company are continually changing, especially in the Construction sector, and good leadership will be characterised by the flexibility to be able to vary the management form according to that most suited to the moment.

The principles that Taylor built on at the turn of the century led to work studies in the Construction sector in the 60s. Later, extensive production control was developed, with time schedules and networks, and methods for developing the organisation, partly in order to lay more emphasis on the human side (strategy development, goal setting, function and responsibility analyses).

Quality inspection arose according to Taylor's thinking. In the last 10 years, quality has been the basis for many organisational and managerial principles. In the 1990s it has been supplemented with other principles, such as logistics (material management), time based management, activity related management, and health, environment, and safety

management. To reinforce the effort in any one area, new posts are often established in a company. In this way, separate systems are developed that have a life of their own, instead of being co-ordinated towards a common goal.

The motivating power behind quality concepts

These may vary. The main motivation is the fulfilment and satisfaction of the customer's needs, requirements and expectations. Many concepts and methods contribute to this, and all should more or less contribute to better efficiency and profitability. The reduction of errors and deficiencies within building and construction is reason enough in itself to use several of the concepts. *Figures 7 and 8* indicate the size of the costs of errors.

Error costs after delivery - external	
Guarantee-period 3,3%	Errors discovered later, that lead to extra maintenance Damages caused by poor facilities management 1,9%

Figure 7. Costs due to errors or deficiencies after delivery are on average 5% of the total building costs, according to a Norwegian survey (📖 7). In addition come costs and losses that have not been measured:
a) Damage that cannot be repaired (internal climate, unaesthetic solutions, low capacity, reduced functional life), b) Damage from forces that exceed the calculation base (catastrophes, improper use by owner/user, altered servicing conditions), c) Damage caused by neglection of appropriate maintenance.

Internal error costs during the building process
"Nonconformity" Repairs, corrections, alterations, re-makes - indications give 5% of total building costs
"Wastage" Materials, equipment, man hours, work environment, calendar time, capital - indications give 5% of total building costs

Figure 8. Costs due to nonconformities, errors, alterations (📖 7) and wastage in the course of the building process are estimated at an average of 10% of the total building costs.

At the same time, quality thinking can rationalise the process. Quality thinking means that each individual worker involved in the process ensures that all the requirements of his/her work are fulfilled. This is more efficient than having an extra inspector monitoring all the way.

In the same way, the authorities' inspections have changed their focus to a monitoring of the documentation that each individual builder or supplier makes of his inspections in accordance with the requirements (Internal control for health, environment, and safety, and Self inspection in accordance with the Norwegian Planning and Building Law). A precursor of the so-called "self-inspection" was to be found in, for example, the Norwegian Standards for concrete work, with appurtenant requirements for inspection.

The introduction of "quality" as a concept became popular as a result of the international standardisation of rules and guidelines (ISO). It is difficult to estimate how

much is invested in national and international work, and how great the turnover for the standardisation institutions is. But the relevant standards are published in large numbers, and there is an abundance of appurtenant literature.

An extensive commercial field exists for consultants, certifying bodies, universities, etc. financed both by industry itself, and by ample governmental grants. These private and public stakeholders together exercise a potent influence and motivating power. For the last 10 years the concept "quality" has been the access key to services and sponsorship in the areas of management and rationalisation in many countries.

Motivating powers external to the company can have both positive and a negative effects. In the long run only an internal motivation can result in enduring improvement efforts, see *Fig. 9.*

External and Internal motivating forces
External motivating forces
- Pre-qualification, contracts, quality assurance, audits.
- Laws, regulations, internal control and inspection
Health, Environment, Safety (HES)
Planning and Building Law
Internal motivating forces
- Customer satisfaction, product quality, "right first time"
- Process quality, without wastage
- Work conditions
- Efficiency, profitability

Figure 9. The development of quality systems in a company can be catalysed by external requirements. But in the long term it is only the internal profitability and focusing on the needs of the customer that can lead to enduring improvement work.

Development of Quality Management in the Construction sector

The international situation in the Construction sector is described in two publications: One of them, CIB Report 168 (🕮 8) contains national surveys from 13 countries, most of them European. The other is the proceedings from the international EUREKA conference from June 1994, with 80 articles from more than 20 countries (🕮 4). The results of a several year long Finnish project have also been published (🕮 9). The development can be traced through many years, since there are also reports form earlier conferences, in London 1987, Copenhagen 1989 and Lisbon 1991.

Quality management is introduced and exploited in many different ways in Europe and in other countries around the world. Many of these differences may be traced to *national conditions,* such as the social culture, management styles, the level of education, the national laws and regulations (products, buildings, health, environment, safety), the level of technical standards, the integration of EU directives, and the practice in the Construction sector (structure, contract design, jurisprudence). Other differences may be revealed by contrasts observed in the *maturity stage of the general management, and the organisation for the building process.* The design and scope of

quality management is deeply affected by national motivating powers and influences. These could be factors such as publicly financed research and development, subsidised pilot projects, the change from public inspection to internal company documented inspection, the requirements of the quality system for public building and construction work and marketing from consultants, standardisation organisations, and certifying bodies.

There are large variations in the degree of maturity: from the embryonic *final inspection* to *Total Quality Management* as a long term and lasting improvement process. This may be due to the fact that the strength of the motivating powers vary from country to country, and therefore what is seen as important, and which concepts are most widely spread vary too. Maturity also varies within each country, according to how long the influence has been exerted, and how intensely. In addition, conjuncture situations have a certain influence. When there are few openings on the market over longer periods, very few companies will invest in a quality system. They would rather use their meagre resources on short term improvements, perhaps based on quality thinking.

The development in the Nordic Countries resembles roughly the development in a large number of other countries. It started relatively early (around 1983), but Finland that lagged for a few years. A survey of the contractors within the TQMNW group (see the preface, page 3), show that most of the elements in their development were pretty well the same (*Fig. 10*). But the chronological order between the elements and the emphasis varied somewhat.

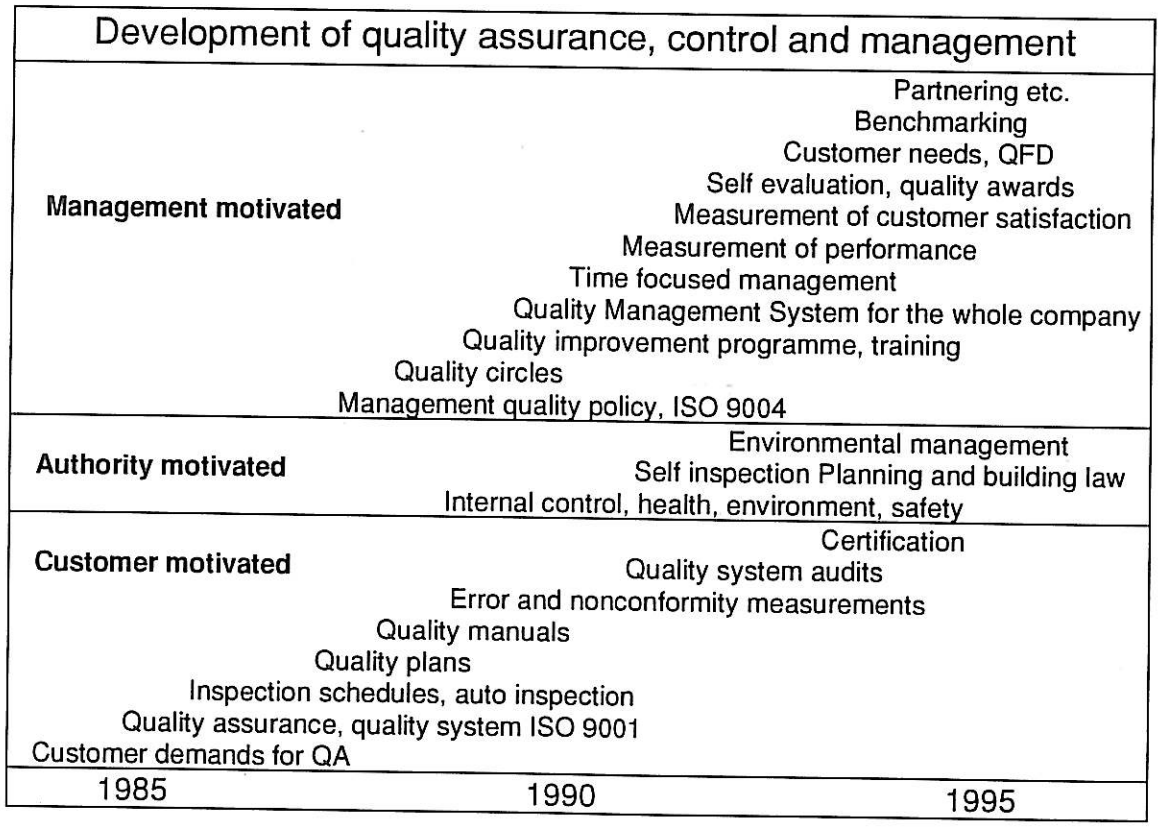

Figure 10. Elements for developing quality assurance and quality management through time, based on key words from the contractors within the TQMNW group. The elements from the

bottom up to the middle are especially customer and externally motivated, while those at the top are especially internal and management motivated.

Culture and tradition give very dissimilar solutions in different countries. England's most widespread certifying is related to the ISO 9001/02, which is externally motivated, while TQM is little used. Japan's Company wide Quality Control - TQC - is directed towards improvements that are internally motivated, while the ISO is "unknown".

In *Fig. 11* we sketch a step by step development, combining external with internal motivation. The employees are involved through a quality programme, and motivated as a result of participation in a controlled improvement process. In building companies it is often more natural to start with a quality plan or a project control plan before one attempts to introduce a collective system for the entire company. Only after this, should certifcation be considered.

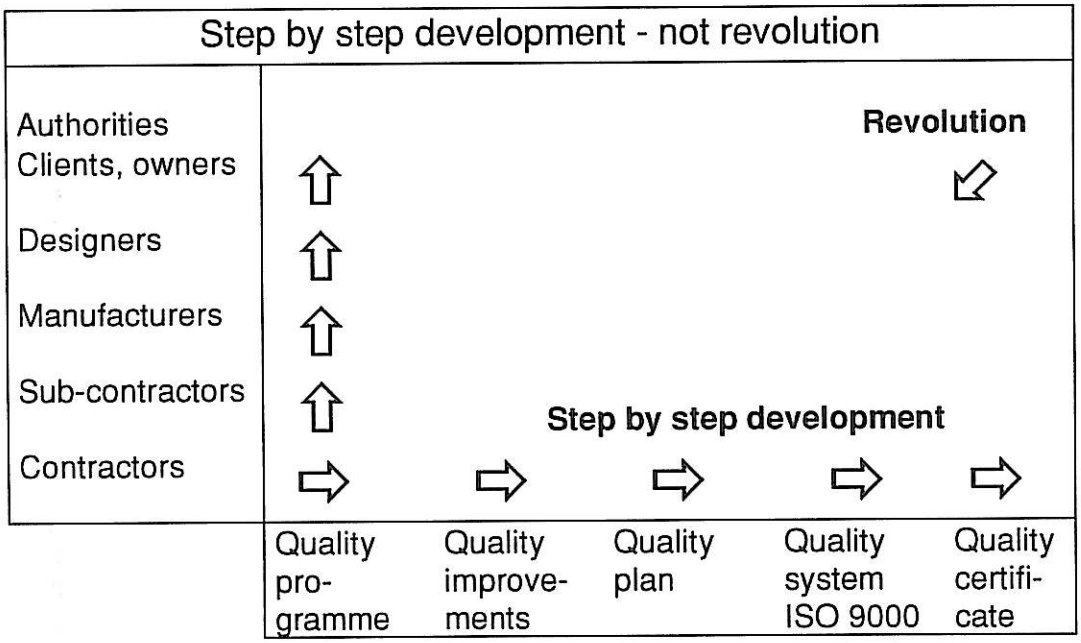

Figure 11. Quality systems must be integrated through a step by step development controlled internally, and not by a revolution controlled externally, and not with the sole intention of achieving the quality system certified as quickly as possible.

The development in most countries started by the main contractors, which both formed the basis of activity for all building and construction activities, and had the best foundation on which to develop the existing management. The process then continued through the other production trades and the various design professions, through the clients and to the authorities. Some clients attempted to control the process from above with their demands for documented quality systems. Few of them understood the consequences of what they themselves demanded. And few of them had a corresponding system to carry out their own tasks, and to follow up their demands in practice. This has resulted in frustration for the contractors and suppliers.

In Denmark, the National Building and Housing Agency already exerted their influence in 1986, by introducing demands for quality assurance for all publicly financed

buildings. This was combined with a five year liability period for all suppliers, and with the establishment of a building damage fund.

The various motivating forces lead to variations in the development activities. This can be illustrated by sub-dividing into the different development phases. In the following chapters, we describe three areas, or levels, see *Fig. 12*. In practice, the methods and aids are combined in many different ways, but all assume that one has, or one is developing, a basic form of efficient management and control through a control system.

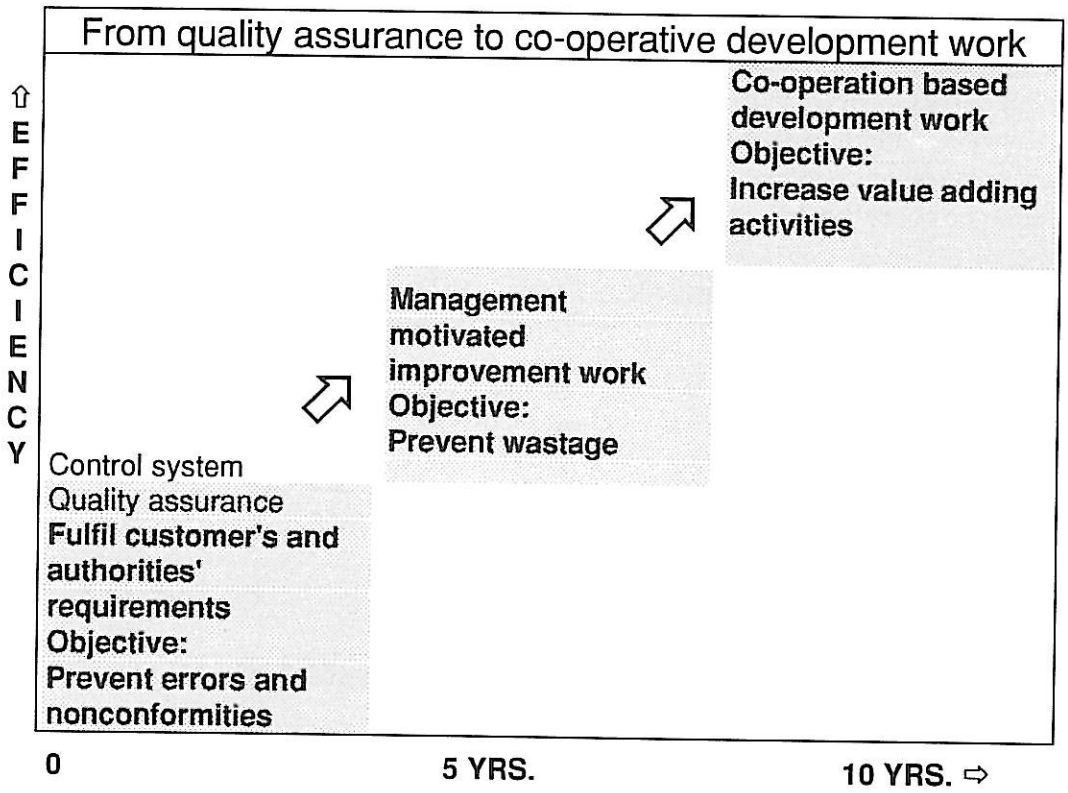

Figure 12. The development of quality management in a company can be illustrated by three levels with increasing efficiency. In practice a positive development may take place over a longer period, but sooner or later the process stagnates. Then, a new initiative is necessary to get it going again.

4. Quality Assurance and Control - key elements in a corporate control system

Quality assurance and quality management build on the motivating power of the fulfilment of customer demands for a system that relates to a quality standard, *Fig. 13.*

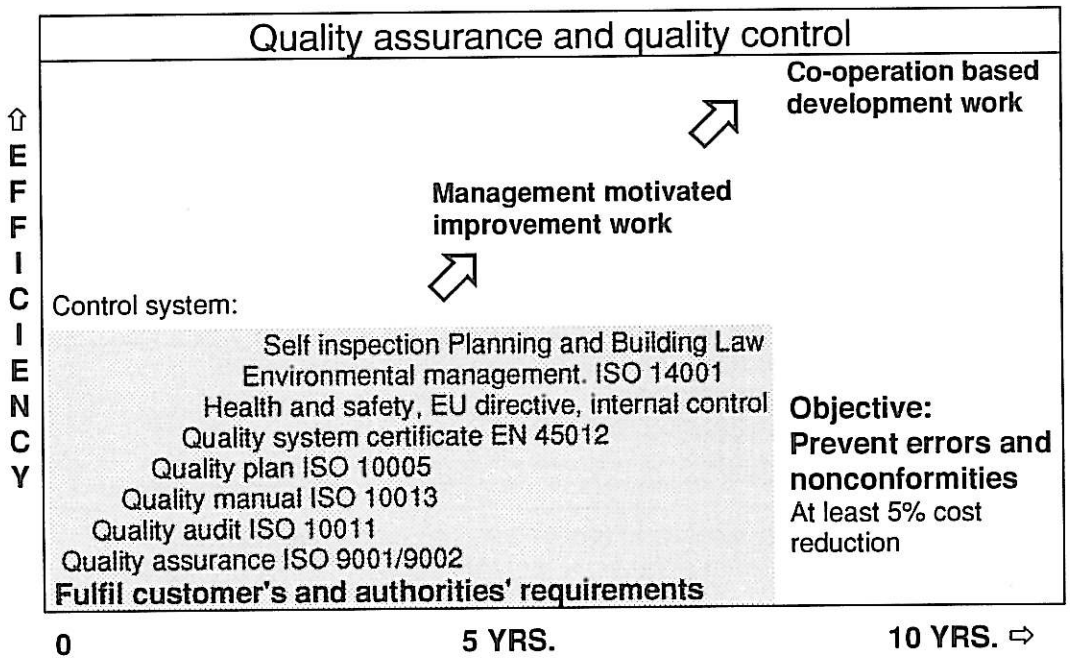

Figure 13. Illustration of customer-motivated quality assurance, seen in the perspective of two further development directions for quality work: quality management to remove non-value-generating activities, and TQM to stimulate new thinking. At the same time the chart shows how the various concepts, by leading from one to the other, can contribute to increased efficiency through time. Authority motivated developments, such as requirements for internal control and self inspection in accordance with the Planning and Building Law, can also make a positive contribution.

The work consists of creating the documentation for a quality system in accordance with *ISO 9001 (02) Quality Assurance*, often with a model quality plan and inspection system for the building site, and perhaps a certification of the system.

The measurements are based on no errors upon delivery, no repairs in the guarantee period, and monitoring of nonconformity costs. The time perspective is 2 - 4 years if one starts from zero, with no system at all.

Quality assurance must build completely on quality concepts, because of the direct link with the ISO-9000 series. These are first and foremost focused on the product (whatever is to be delivered/handed over).

Quality assurance and quality control are both built upon ISO standards which were originally created with stationary industrial activities in mind. This has created problems for its understanding and practical application in a building and construction context, due to its predominantly project oriented activities. In many countries, special interpretations, guidelines and recommendations have been added for the use of quality standards in the building industry.

In Europe this type of special category is most widespread in England where a third party certificate is quite common. Also some countries in Southern Europe lean in this direction, as does Germany. In most countries the usefulness of certifying is strongly disputed in the Construction sector, see *Fig. 14.*

Third Party Certification
Possible positive effects - Hastens development, motivates, supplies a milestone - Stimulates a discussion on objectives, methods, responsibility, processes and procedures **Possible negative effects** - Focuses on the paper system, not the efficiency - A certificate becomes the target, not an increase in quality level - Investment in the certificate as a marketing ploy - Control of the company's development is taken over by an external consultant or certifying organisation - Quality assurance is the objective, not quality management - Little emphasis on participation, improvement and new thinking

Figure 14. Certifying the quality systems of design and production companies in the Construction sector can have some advantages, but also involves the risk of disadvantages.

Customer motivated quality assurance is often the start of the journey towards real quality work in a company. It is important to integrate it as a part of the existing organisation, management and control. In this way the company will improve its collective management.

But focusing on preventing errors and nonconformities is a difficult access route. It is not easy to motivate workers to the filling out of more forms, specially when those forms exist, to a large degree, for external purposes. At the same time, there is a risk of too much emphasis on the final product and inspections. Therefore the management must, at the earliest possible point in time, steer the development towards an internally motivated process, where the workers can feel engagement and can contribute to continuous improvements. One can, in such a process, integrate elements from external requirements little by little. We will come back to this in the next chapter.

5. Quality management - developing a corporate management system

Quality management is motivated by the company's efforts to increase efficiency through the management's emphasis on satisfying the needs of the customer, *Fig. 15.*

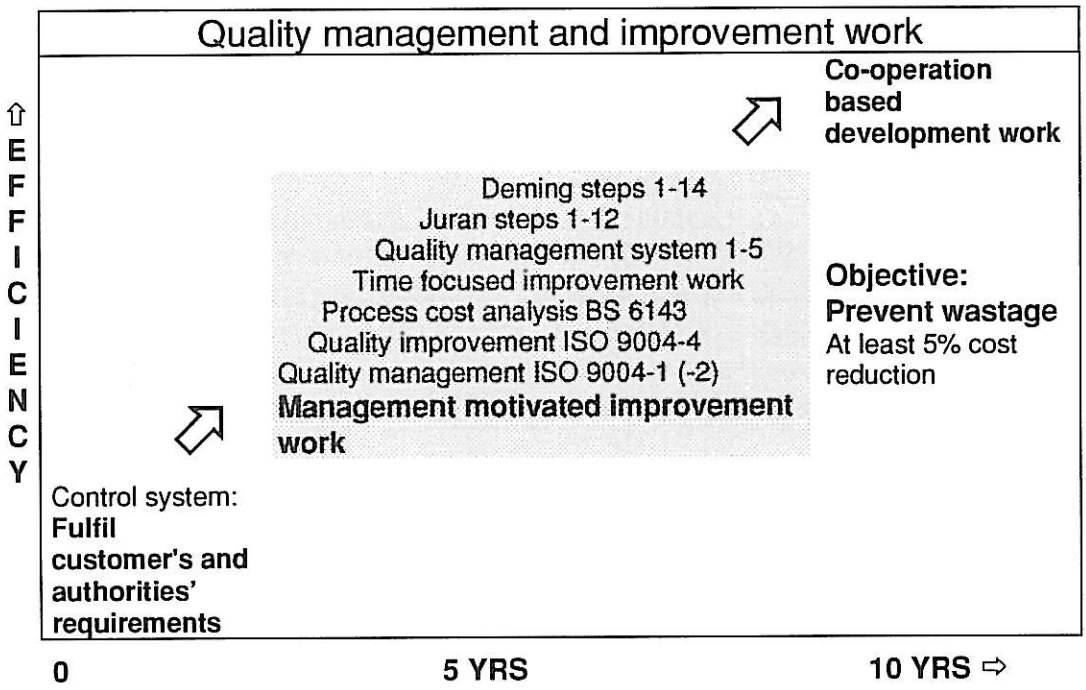

Figure 15. Illustration of management-motivated development of quality management and improvement work, to remove wastage and non-value-adding activities.

One method could be to develop the existing basic company and project system, supported by the *ISO 9004-1 (-2) Quality Management*, all aspects dealing with health environment and safety, and the fulfilling of the Building Law being integrated in the same system. One other approach (or in combination) could be to organise an on-going improvement programme, accordingly to the *ISO 9004-4 Quality improvement* or a similar system.

Cost reductions and other improvement aims for the reduction of nonconformities, for continuously decreasing wastage or over consumption of any form, and for the reduction of non-value generating activities should be measured (🕮 1).

The time perspective for integrating a work style with continuous built-in improvement is about three to six years after the start of the quality work.

The development can build on the general principles for management, control and rationalisation, with particular emphasis on the satisfaction of the customer. It does not

necessarily have to be built on quality definitions. It should focus more on the actual process.

Quality management and improvement work have their foundations on a rather more flexible idea of customer satisfaction than on quality assurance. Methods and techniques have been tried out and adapted to the Construction sector in several countries, and a good many of large contractors have followed this direction. The critical assumption is that the managers are able, or can learn to lead the improvement process, and are willing to involve themselves in this work.

One model that has been tried and tested is the *Quality Management System* (QMS), which combines company and project management. This has been introduced in about 400 companies, mostly in the Netherlands and the Nordic countries (📖 4, page 82). A collection of model forms and examples are worked out for many different sections of the building trade.

The great challenge is the organisation of an improvement programme. It could well be based on the *ISO 9004-4 Quality improvement.* Such a programme should be linked to the company's basic organisation, and develop as a training process, where all the employees are actively engaged. One follows a step by step programme with periodical monitoring. This can be based on suggestions from Deming, or Juran or the five step system of the QMS, for individual companies or for groups of companies, see *Fig. 16* (📖 4, side 85).

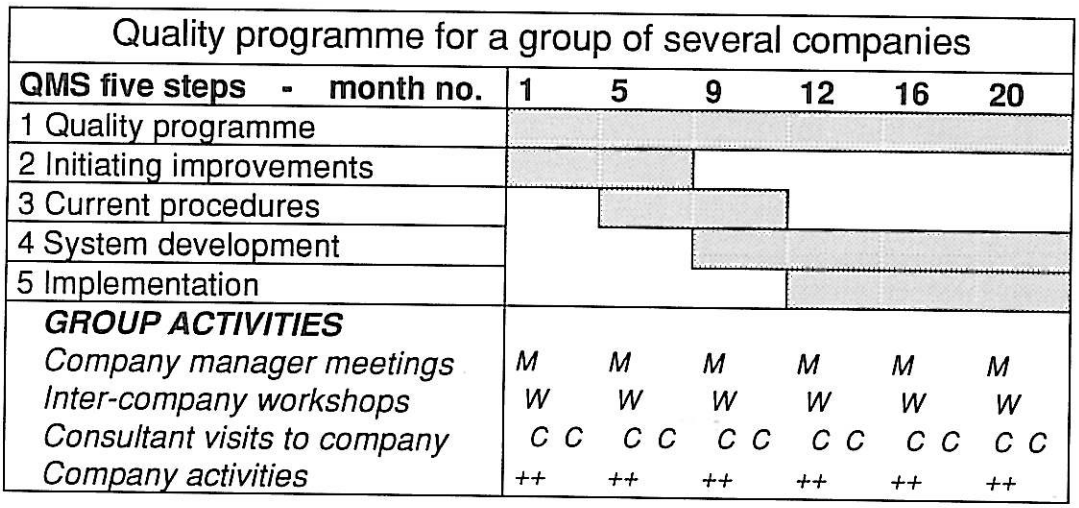

Figure 16. Integration of the quality system can be brought about through a co-operation between several companies in a group, with a common consultant.

There is still a need to look closer at the methods for implementing the quality concepts (and for internal control and self inspections). There has been little stress on the operational and human side of introducing a process of change into an organisation. A term for this, the "Quality programme", comes from a dictionary from the European Organisation for Quality (📖 10), but it is not defined in the ISO standards. Possibly the term "Quality programme" will be replaced by the term "Quality-improvement plan", see ISO 9004-4, 5.2.

In ISO 8402, "Quality planning" has received a wider definition. Here Quality Planning includes the organisation and planning of the *implementation* of the quality system, the

drawing up of a quality plan, and the *preparations* for quality improvements. But there are no guidelines explaining how such a process can be carried out.

Collective motivating forces for the improvement of methods and integration of quality systems do not exist. Only consultants market processes for self development, while the companies mostly demand ready documented "systems". A company invariably wants a quick solution from an expert consultant, a solution from which the company learns little. A process that facilitates self education takes considerably longer, but is absolutely necessary if the company is to achieve a durable self-driven improvement process.

Above all it is the mangers of the Construction sector who need to acquire better knowledge and understanding of how they influence their own organisation. Experience and surveys show that there are many pitfalls, *Fig. 17* (🕮 11).

Psychological factors and pitfalls
Focuse on peoples' motivation for improvement (in addition to knowledge and skills) - Leadership style and culture: model for employees, or own rules for managers? - Degree of employees' participation - involvement is necessary - Measurable goals, and feedback from the mangers must be experienced by all - Communication, dealing with conflicts must be mastered

Figure 17. There are many pitfalls of a psychological character when establishing quality management and quality systems.

Much can be gained through better practical methods by which companies can develop and integrate their management systems in such a way that they really are exploited.

Once the organisation has arrived at a method for the efficient integration of quality, it can use the same method for the internal management of health, work environment and safety, and for self inspection of the fulfilment of Building Regulations or other aspects.

The greatest challenge is to ensure that the intentions are understood by everybody in the company, and that a work style of continuous improvement becomes a part of the daily activity of the company, without a fuss having to be made about "Quality improvements" as such. This is a long way to go, and the managers must be prepared to go first and lead the way.

6. Total Quality Management - for the more advanced

Total quality management involves the company's committing itself to a strategy where further increases in efficiency are achieved through intensive holistic analysis, and co-operation with both customers and other stakeholders, such as suppliers and employees, see *Fig. 18*.

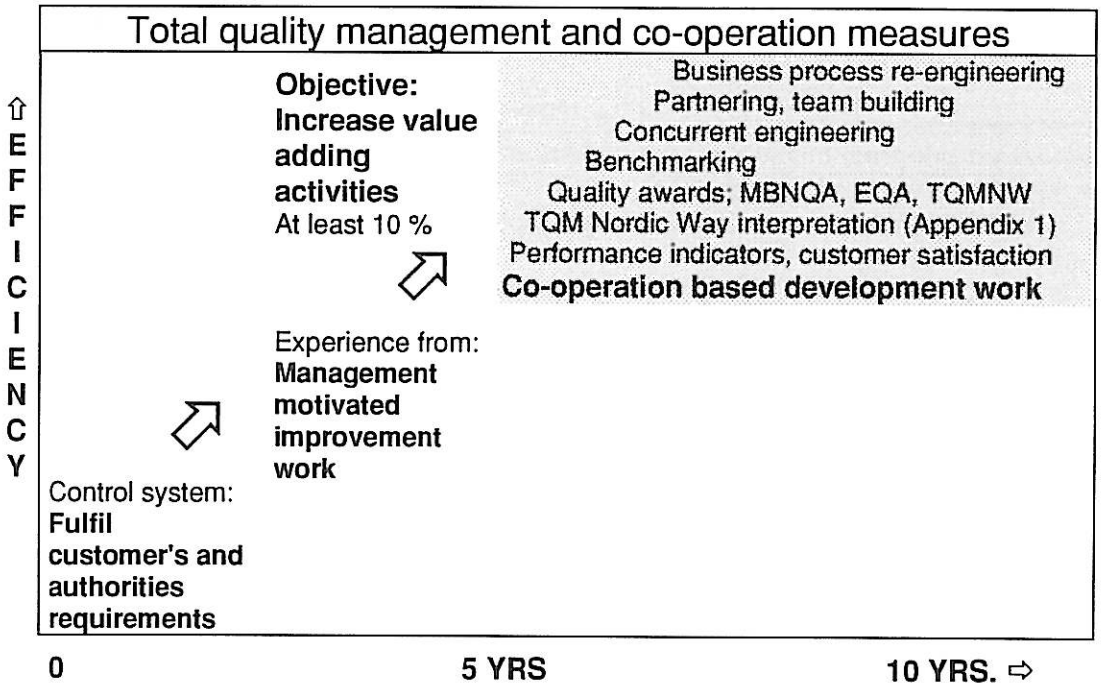

Figure 18. Total quality management and co-operation-motivated development work for stimulating new thinking can build on many elements.

The process can build on a cyclic renewal of management philosophies, strategies, management of resources and project execution, based on continuous measurement and monitoring. The improvement process is expanded to include e.g. Benchmarking, Partnering, Business Process Re-engineering - and self evaluation with use of criteria from quality awards (*Fig. 19*).

The measurements can be linked to performance indicators, comparison with competitors, satisfaction of customers, and point sums from quality award criteria.

It will take a long time for a company that initiates quality improvement to achieve, e.g. 70-80 % of the maximum point sum for a quality award, 8 to 10 years in best case.

The process builds more on *basic management concepts*, control and rationalisation, than on special quality concepts. The emphasis is on satisfaction of all parties with a stake in the company's activities.

Companies may have combined the concepts discussed in Chapters 4, 5 and 6 in different ways, or a different order. But all had, at the beginning of their "quality era", existing systems for management and control more or less documented. This basis is further developed through several years of quality work, and is the condition for being able to commit to TQM.

TQM can involve forms of co-operation and communication with external stakeholders. This possibility is poorly exploited in the Construction sector, but the improvement potential must be extra large where the typical framework is the continuous commencement and conclusion of one-off projects, with constant changes in the organisational structure. The large contractors of Japan and the USA work in this way. In these two countries the sector is, as yet, little influenced by the ISO standards. Some European contractors also work in this way after many years of experience with quality management.

The contractor group TQMNW have worked out a special interpretation of ISO's definition of TQM for contractors, see *Appendix 1*. The group has also drawn up three sets of criteria for point awards based on the American Malcolm Baldrige National Quality Award (MBNQA): one for contractors, one for building projects, and one for the construction site (🕮 1). The European Quality Award (EQA), after its introduction in 1992, has become more and more widespread in Europe. In Denmark it is used as a national quality award, and in 1996 the Norwegian quality award will also be adapted to the European award. The main principles of the majority of quality awards are similar. One sums up points from the answers to questions dealing with a number of different aspects, see *Fig. 19*.

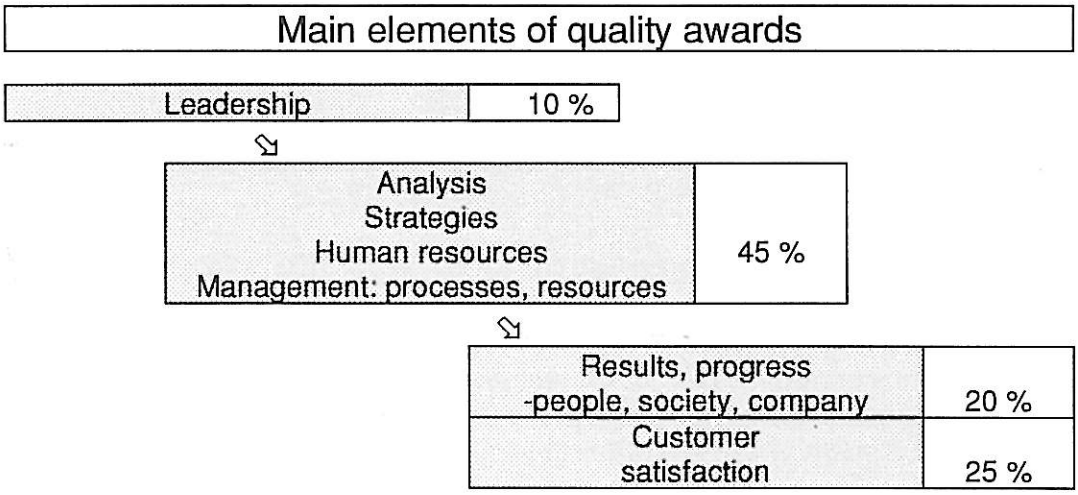

Figure 19. Quality awards are established in many countries with similar evaluation criteria.

One of the companies within the TQMNW, that has been working with quality assurance since 1982, started an internal process for Total Quality in 1991 (🕮 4, page 514). The programme has developed from the learning phase to a running priority of improvement activities that apply to all levels of organisation. Internal evaluation against the criteria of the European Quality Award was also included in the programme. The company later went through a curtailment phase, where it could also take advantage of the internal process that was under way.

Development methods in the Construction sector

Progress in improvement work is dependent on the identification of the areas to be improved, priority setting, goal setting, the management of improvement measures, and the measurement of improvements. There are a number of written aids for the reduction of errors and deficiencies during the building process, and for the reduction of wastage (🕮 1). On *Fig. 19* we mentioned the criteria for award evaluation, as an aid to identifying potential areas of improvement, and setting goals. Often new variations of the techniques and written aids are presented as "news" under new names. Here, we will comment on those development methods that are most relevant at this point in time.

Measurement of Customer satisfaction

The measurement of customer satisfaction is at present being researched by a work group from the TQMNW. Experience shows that customer surveys often assert other needs and priorities different to those the contractor had assumed. One company revealed the difference through a parallel survey of its own employees and the external customer.

One company, that concentrates on house building, systematically issues question sheets that indicate the degree of satisfaction with the company's performance to everyone that purchases their houses before contract signing, during the building phase, and on handing over. The answers are summarised in a performance indicator that is used to set and follow up improvement goals for future projects.

Another example is the asphalt supplying company that carries out an annual survey among a sample of customers. The results are summarised in a "Satisfaction Index" , which includes quality both of product and service, and factors such as time and costs.

One company has also questioned internally about how satisfied the production department (the internal customer) was with the design department.

Feedback seldom comes from customers and employees unless there is something to complain about. Therefore the company itself must establish suitable methods of measuring as a basis for continued improvements. This is particularly important in the Construction sector since the majority of the customers are not sufficiently professional to be able to formulate their requirements and wants in a concrete fashion, and because the building process involves so many different parties.

Quality Function Deployment - QFD

Quality function deployment is a systematic method for satisfying the customer's requirements, needs and expectations of a product or service as far as possible. The method is suited to a situation where there are many factors to be taken into consideration simultaneously. One can clarify and grade the importance of interrelations by using several matrixes and a priority grading system (a "deployment") see *Fig. 20.* The method is described in (🕮 12).

The aim is to focus on the customer's actual requirements, and to give priority to the functions and features that are important for the customer. The method aids

communication in an interdisciplinary group, preferably together with the customer. The result is documented effectively through the matrix and appurtenant deployment. In practice one should make use of a computer programme so that such an overview is available at all times, and running deployments can be made automatically. One writes in the priority grading for various wants and functional requirements, and out come calculated values for absolute and relative importance. The method is complicated and time consuming to follow completely. But one is free to choose the scope of the analyses, and certainly at the beginning this should be limited. It is a good idea to start with an area where the results can be of use in many contexts.

One contractor within the TQMNW reported that this method was useful in the planning of a new housing estate. Special emphasis was given to the design of the kitchen, see *Fig. 20.* It was revealed that the clients's priorities were quite different to those the contractor had imagined before the survey.

Deployment of client's functional priorities							
Object: kitchen		**(2) Function/design features** 1 Floor area, 2 shape of room, 3 position, 4 window area, 5 temperature, 6 lighting for work					
(1) Client's wishes Priority grade ⇩		1	2	3	4	5	6
Cold storage	*8*	○	○	⊙			
Frozen storage	*9*	○	○	○			
Dry storage	*7*	○	○	○			
View	*5*	○	●	●			
Comfortable inner climate	*4*	○	⊙	⊙			
Exit	*5*	○	⊙	●			
Large area	*7*	●	⊙	○			
Rational cooking	*9*	○	●	○			
Lighting	*9*	⊙	●	●			
(3) Sum: **Priority grade x Interrelation**							
Requirement value		*12*					
Unit		*m^2*					
Calculated priority, absolute		137					
Calculated priority, relative		14 %					

Figure 20. A set of matrixes are an aid for the systematic analysis of wishes and requirements. First one lists the client's wishes and priority grading (1). Then one sets up columns for all the types of functional requirements (2). Then one evaluates the degree of interrelation between each wish and each functional requirement, and draws in the symbols e.g. large (● = 9), medium (⊙ = 3) or small (○ = 1). Finally, one multiplies the client's priority grade with the interrelation grade, sums up the numbers in the column for each functional requirement, and fills out the sum under calculated priority (3). The totals give a basis for the priorities of the final design.

A forth step can be an analysis of positive and negative relationships between two and two functional requirements, to improve the basis for choices. A fifth step can be an analysis on how a competitor fulfils the client's wishes.

The Construction sector can use this method to determine what products should be offered to the market, and what the customers prefer, and to analyse one's standing compared with that of competitors. In the programming and design phase of a project one can use the method to clarify the demands of the customer, and what influence

these have on the design of the components. Through this type of design, one can balance the various requirements and choose solutions for the various components that best fulfil the wishes of the customer. At the same time, this technique can be used for the selection and development of the best execution method.

Concurrent engineering

Concurrent engineering involves the parallel analysis of design solutions and production methods in order to achieve a better total result. This can also give a faster completion by shortening the time between start up of design and production start. Design is carried out simultaneously for several disciplines, and is split up into several parallel geographical areas.

A company within the TQMNW has experienced that one can shorten the design time considerably by giving a "complete package" to specially chosen sub-suppliers who are then responsible for the development, design, production, installation, service and guarantee of their component, see *Fig. 21*. This system was used for constructing a very large business centre, but had a very short dead line for handing over. The advantages were shorter total project time, lower costs, a clarified responsibility assignment for design and installation, and a combined development and design. There were disadvantages in connection with time co-ordination, finding suppliers with sufficient capacity for development and design, the design of the purchasing strategy, lack of familiarity with the method (first time), monitoring the design, aesthetic requirements and dealing with design changes along the way.

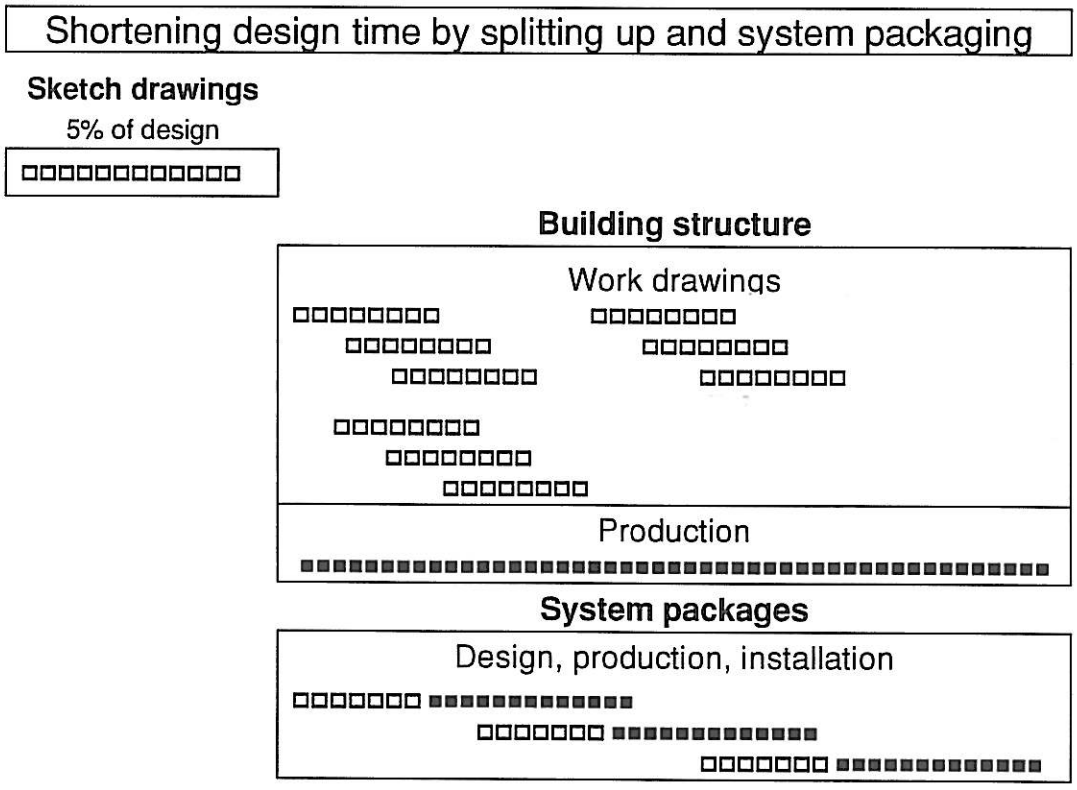

Figure 21. Shortened project time, by splitting up the planning and design for the building work, and by sub-contracting complete system packages that include design (□), production and installation (■).

The consequences of a such splitting up and overlapping are obvious, and demand a good deal extra of organisation, communication and decision making processes. The clients' needs must be systematically determined, be clarified before the design phase, and cannot change along the way. The organisational form must be such that it favours co-operation between design and production, and communication must be speedy. Success is conditional on the co-ordinated use of computer systems, and that the principles of quality assurance are carefully followed by all.

Time based management

Time based management aims at the improvement of efficiency through a continuous effort to shorten process times. The Construction sector focused more on time management in the 1960s and 70s. Lately, a new demand for shorter building times has given rise to a wish for better time control. Some larger companies have chosen to focus their project planning on well defined goals for the achievement of reduced production times. As a result, they claim to attain lower costs, a better working environment, and fewer errors and deficiencies.

One of the TQMNW companies has, since 1991, been putting its efforts into integrating planning principles for achieving shorter times throughout the entire organisation (🕮 4, page 344). The following are example of activities within this programme:

- Basic activity: the specialisation on functions and product types that give higher efficiency and better feedback of practical experience
- Basic activity: new responsibility assignment between design engineers (production planning and monitoring) and production manager (execution according to schedule and error-free fulfilment of all requirements)
- On-going improvement programme within all company departments and levels, with execution and monitoring to achieve concrete goals
- Supporting activities by a team within the company: training, general quality system, guidance for quality planning, measuring and monitoring system, control of purchasing and logistics.

Logistics management

Logistics management involves controlling the material turnover from start to finish. One of the measures is to reduce all waiting and ensure delivery at the correct time ("Just in time"). This is important when the material costs or the costs of subcontractors constitute a large part of the total, when interest rates are high, and with special distribution or storage conditions. The potential for rationalisation is particularly great in the Construction sector, through improved communication between contractors and suppliers. Efficient use of computer networks, bar codes, etc. can give easy gains to co-operating parties.

Partnering

The word *partnering* comes from the USA, and is used for various types of co-operation. It can be applied to individual projects or long term connections, and can vary from rules of behaviour to incentives or extensive business agreements. The point is that the interested parties, through co-operation, become more efficient and competitive together, and therefore also as individuals. Instead of fighting to get the

upper hand over each other (win-lose) the message is that they should share the gains of working together (win-win).

The Contractor Sector of the USA has defined partnering as a set of rules of behaviour for an open and trusting co-operation between owner, contractor and other parties involved in a building project (🕮 13). The rules are not included in the contract, but the top managers from the participating companies sign an agreement. This agreement states that all participants shall work together towards the common target as well as towards all their individual goals. This co-operation agreement may, e.g. describe the policy for open and efficient communication, steps for internal solving of conflicts and the goals for the execution of the project. In order to establish the partnering co-operation, a special system for information, and meetings with special consultants are suggested. One of the stated advantages is a considerable reduction in the number of disputes and court cases.

The concept of *partnering* also applies to co-operation that lasts longer than for a single project. The objective is a mutual adaptation to increase the collective efficiency and the individual's advantages. There is enormous potential for this type of co-operation within the Construction sector.

One of the TQMNW contractors has chosen to sign an agreement with a supplier of building materials. The supplier has preference at the same time as the contractor has the status of priority customer. The two parties can thereby control their sales and purchasing according to a common goal of increased ability to compete. The following points are included in the agreement: communication, priority of invitation to tender, tenders and offers, annual prognoses from the contractor, tailor made catalogue of wares from the supplier, annual seminar for contractor's purchasing and production personnel, hearings for the supplier's quality assurance, mutual development of logistics system and common marketing and profiling tactics.

Team building

Team building is a method of initiating larger projects, where the individual participants, preferably including the customer, build up mutual trust and understanding in a systematic fashion, and lay the foundation for an open and efficient co-operation. There are recipes for organised meetings and exercises. Themes such as inter human relationships, roles and rules of play for the project, company cultures, and a common understanding of the project objectives regarding safety, execution time, economy and quality are addressed. The aim of team building is the same as for partnering, and can be seen as a simpler and less formal measure for paving the way for good co-operation in a project.

Benchmarking

Benchmarking is a systematic comparison between one's own and others' processes and products, in order to reveal potential for improvement. The most usual method is to compare oneself with one's best competitor, or, for limited functions, to compare oneself with a particularly well-reputed company, irrespective of the sector the company belongs to. Within large organisations, this can also be done internally.

An example from the USA is the company that produce and deliver nearly 2000 different mixes of concrete and asphalt. Benchmarking for delivery precision against the most effective pizza delivery firm revealed that the use of an updated map of the day's traffic jams led to considerable improvements. But the greatest improvement came when a driver asked whether one couldn't mix the concrete faster by using credit-card technology. Computer control reduced the loading time by more than 50%.

A TQMNW work group is at present (1995) investigating the use of Benchmarking in the Construction sector. One example is the comparing of one's own purchasing procedures with a ship builder, and with a rock drilling machine producer. Another example is the comapring of one's own sub-supplier relationships, with those of a car factory. Many ideas have arisen, but the problem is to limit and define one's own processes so that one can set concrete improvement goals and follow them up. There is no point in Benchmarking with no following up measures.

Business Process Re-engineering - BPR

Business process re-engineering involves radical new thinking and re-designing of a company's methods or basic activities in order to achieve a dramatic improvement of critical factors such as costs, quality, service and time (📖 14). The background is often an acknowledgement of the necessity of a significant change of course that cannot be achieved by the existing improvement work. This may be due to changes in the relationships with customers or market circumstances, to acquisition of new technology or new use of information technology.

One main method is the systematic analysis of the company's main activities, through the drawing up of the process chain of the product or service delivered to the customer. Then the main activities are surveyed from the customer's point of view, and which of the activities generate value for the customer, i.e. ensure that the gain is greater than the cost. One then seeks to remove or reduce everything else. Here creativity and idea development must be given free rein. What other alternatives are possible? Other forms of organisation? Other forms of co-operation? The results of such analyses will vary according to the strategic framework on which they are based. Another approach is to start more freely, without linking the analysis to current processes. This is particularly applicable when one already has an idea of what one wants to do, or will evaluate the use of new technology. No collective recipe for arriving at new and better solutions exists. A clear and realistic target is one of the best motivating forces.

The Construction sector has developed into many fragmented and specialised disciplines and professions, with many different types of sub-supplier. At the same time, the extensive and continually expanding standardised methods for contracting, calculations, and methods of measurement, etc. serve both to bind together and to limit freedom. The branch as a whole would greatly benefit from radical changes, the development and integrating of new solutions would require extensive co-ordination between a large number of parties. Co-operation-motivated development and total quality management are at present key words that are limited to a few more advanced actors within the Construction sector. It is up to these leading organisations to demonstrate the effectiveness and practicality of their development, so their methodologies can be validated and implemented within the rest of the sector.

7. Improvement of management and control in the Construction sector - the responsibility of the actors

Focusing on the needs and expectations of the client and the user

Those contractors that have come furthest in the exploitation of quality concepts have introduced techniques and written aids for the reduction of nonconformity, and for a continuous improvement process, where participants are actively involved. But the basic theories and quality standards (ISO) deal first and foremost with companies as a whole, and not with projects. This problem particularly applies to the role of the client and the design team, somewhat more than to the production team. The focusing on quality concepts in the last few years has probably deviated the attention from the development of design and build, which is the core activity of the Construction sector. At the same time, it has made people in the industry aware of how much can be saved by focusing on the right quality and on improvement work, see *Fig. 22.*

Potential savings for the Nordic countries			
Areas of costs	Estimated quality costs from nonconformity and wastage as **% of total annual production** 1)	**Improvement goals %** of all damage, all nonconformity, all wastage	**Annual improvement goal in millions NOK.** (Total production 535 000 mill NOK)
Damage repaired under guarantee	3 %	25 %	Ca 4.000
Extra or defective maintenance	2 %	25 %	Ca 3.000
Nonconformity in process	5 %	25 %	Ca 7.000
Wastage in process	5 %	25 %	Ca 7.000
Total	15 %	25 %	Ca 20.000

Figure 22. The collective savings potential is estimated at 15 % of the total annual production, see. Fig. 7 and 8. If one took 25% of this amount as an improvement target, the Nordic Building Industry would save some 20.000 million Norwegian crowns annually.

In the 1960s the development of the building process itself was in focus, among other things, with the analysis of information flow in and out of the activities. The quality techniques of the 1980s and 90s have displaced the interest more towards the development of the company, limited to those parts of the process the individual company is responsible for. What has been lacking is the adaptation of quality management to the building process. One factor is that the process itself is complicated, each new project demanding a whole new organisation of a new constellation of

companies and participants, new suppliers and a new building site. Another factor is the complexity of integrating each company's own objectives and management system into a common project objective and co-ordinated project team. With this background it would be correct to say that the next challenge is holistic leadership of the entire building process. There are still too few customers that are sufficiently competent and motivated to openly and directly co-operate with the other building participants in a partnering situation. Even fewer are sufficiently powerful and professional to lead the further development of organisation and management in the building industry. In some countries, a few large contractors have taken over the leadership of many large building contracts through design and build contracts. But many of these still have too little knowledge of the process of project development and design.

Examples of improvement areas within the management and control of the building process

As a basis for our evaluations of possible improvement areas we may look at the sources of the damage after delivery, see *Fig. 23*. It indicates that circumstances in the earliest phases have the greatest influence on the end result.

Causes or sources of damage after delivery	
Actual causes (sources)	**%**
The customer's framework conditions	20 %
Neglected programming of clients needs	20 %
Deficiencies in project documents	20 %
Production deficiencies	30 %
Deficiencies of materials or products	10 %
Total	100 %

Figure 23. Reasons for errors or deficiencies after delivery can be traced back to all phases of the building process. A large part refers to those decisions the customer himself could have directly influenced (🕮 7).

Better clarification of the client's needs and requirements

The Construction sector's alteration of course, from focusing on products to focusing on the customer and the market is well on its way. But there is still a long way to go before the culture and work style of the sector has in reality aligned itself with the customer.

The first area with lots of potential for improvement is the clarification of the requirements of the client and user, including considerations of operation and maintenance of the building. This must take place already at the initiation and programming phase. In this context, concepts of quality management have much to give, but still the basic principles for project management are the most important.

The most basic improvement would be an introductory clarification of the client's needs and requirements. This includes what uses are intended, with definitions of quality in use. In addition the building must be user friendly as regards running and operations, with requirements dealing with maintenance.

The requirements must cover functionality as well as aesthetics, and be measurable either objectively, or by methods developed from subjective evaluations. Any other framework conditions, both from the authorities or from the customer must also be defined, and included in plans to achieve an optimal execution: the right way at the right time in the process.

A customer must also have access to guidance during the process, so that he can take the right decisions in the right order. The Construction sector must accept the responsibility for forwarding suitable methods to help the customer.

Better control over the design process

The second important potential improvement area is the development of processes for design and construction. It is necessary to raise the level of the design management to at least the same level as the production management. At the same time, production knowledge must be better exploited, if necessary, through design and build contracts or other contract forms that favour co-operation.

Better communication of requirements throughout the building process

The third, and most extensive potential area for improvement is the development of the building process in its entirety. The fragmentation of the building process demands a degree of integration on behalf of the parties involved, in order to achieve an optimal total solution. The objective is to get the parties in the building process to change their attitudes from managing and competing purely for their own gains to a co-operation on common interests in order to satisfy the customer and user as far as possible.

Better integration involves systems for management and communication that diffuse the entire supply chain. The system must ensure efficient communication of needs and requirements throughout the whole process, and include internal customer-supplier relationships.

Furthermore, the system must include step by step acceptance of solutions. This includes the clarifications of interfaces between contracting parties, and the mastering of parallel construction and production. The system must also include the collecting in and exploitation of practical experience gained (feedback), both within the project and between partners.

Quality Plans as a tool for innovation in project management and control

In the last few years, Quality Plans have been introduced as a new aid to ensure quality in building projects.

A Quality Plan is defined as "A document setting out the specific quality practices, resources and sequence of activities relevant to a particular product, service, contract or project" (ISO 8402). In the building process each party draws up an individual quality plan for each project, *Fig 24*. At the same time these individual plans are co-ordinated into one common plan, which particularly specifies deliveries, and communication between the parties.

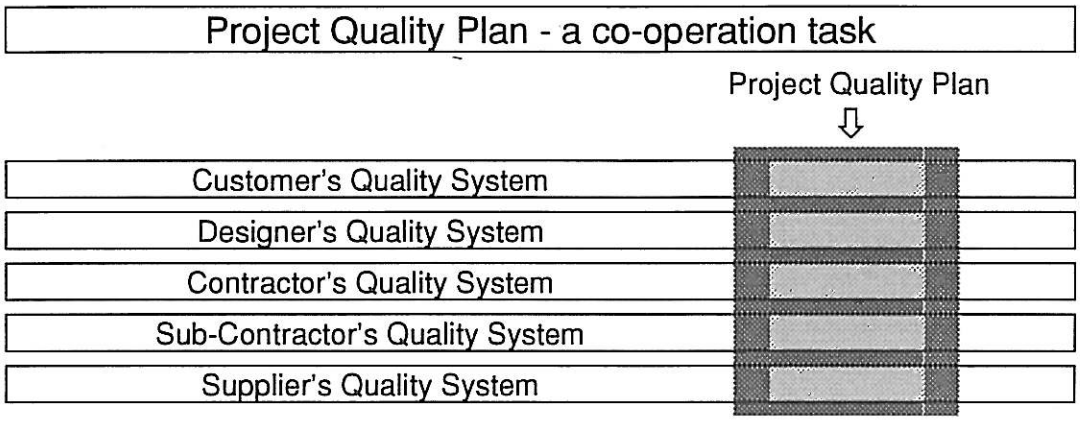

Figure 24. On the basis of their quality systems, each participant draws up a project quality plan (light shadow in the diagram). All these plans must be co-ordinated to a single common plan (dark shadow in the diagram).

There are no clear requirements for the content and structure of a quality plan. But the ISO standards make it clear that a quality plan can be a *part of the whole project plan* (see definition p.17). The project plans for the execution of building projects have been more or less well documented. But customer demands for quality plans can certainly stimulate the freshening up and improvement of the collective project management.

Quality Plans are a relatively new concept in the Construction sector. There are great individual variations in what is understood as being included in a Quality Plan. The TQMNW group surveyed 20 quality plans from 10 lands: Belgium, Denmark, Finland, Holland, Italy, Japan, Norway, Great Britain, Sweden and Germany, to see just what can be included in Quality Plans. Most examples were from contractors, but a few were from designers. The contractors quality plans showed little coverage of the programming and design phase. So although the survey material contains both examples from design and production, the weight as a whole, is on production. Most plans referred to existing procedures and aids from the basic organisation.

The list of contents of the 20 Quality Plans were collected and sorted according to ten aspects that reflect the four phases of the Deming's Cycle: plan, do, check and act (see also *Fig. 4* earlier in this report). After removal of all topics that were repeated, the result was edited to a summary of the total content of 20 plans, see *Appendix 2*.
A number of basic management elements appear in the majority of examples, such as organisation, assignment of responsibility, project review, inspection, handling of nonconformities and system audit. The greatest difference lies in the fact that some cover a limited quality assurance documentation, dictated by external factors, while others cover total project management, including, among other things, the management of internal economy.

It is also worth noting that the examples of project management focus more on technical inspection than on a clarification and following up of the client's needs. The feed back of practical experience was only mentioned in four of the plans. 18 of the plans were structured more or less according to the building process, while two of them were structured according to the chapters in the ISO 9001.

Communication between parties is simplified if one uses a number of common elements in the plans. *Appendix 2* shows how 10 central management aspects can be used in the

same way for all parties in the building process. Each party can use this system of sub-division for its quality plan, possibly divided into chapters for each of the building phases (e.g. programming, design and production).

The concept of Quality Plan has established itself rather at the cost of the concept of Project Plan up to now. This is an unfortunate development. The greatest need is for a plan that includes all aspects of management and control of a project. With a good, systematic overview, this can contribute to a holistic management and control, with a better co-ordination of the various participants. Therefore we recommend that one goes all the way, and establishes project plans as the paramount solution for the future.

Improvements in management and control do not come of their own accord

Typical of participants in the Construction sector is that they are very flexible and that it is part of their culture to adapt to external changes as they arise in the market. This must be changed to a strategy based on investment in research and education to influence or lead the development with a longer term perspective.

Both the need and the potential for the improvement of the management and control in the Construction sector is great. One must focus less on the product, and more on the market and on the customer. This is conditional upon a better clarification of the client's and users' needs and requirements. Throughout this report we have emphasised how quality thinking can be put into system, both for better control of projects, and to achieve a running improvement process to increase innovation and profitability. Above all, we must develop the building process into a holistic co-ordination with better co-operation between stakeholders. This includes the companies as a whole, the employees and the authorities.

Changes in the Construction sector come about slowly. Five years is a short time in most contexts. The tempo can be influenced by the establishment of networks and mutually committing alliances (partnerships) by powerful participants who can take over the leadership and set the tone.

In the Building and Construction Industry it is usual that research and development are linked to techniques and products. We recommend that parties to a much greater degree regard management and control as improvement areas. The sources for research and development grants and funding must give priority to this area and ensure that the sector itself becomes involved at the same time as exploiting the competence of professional resources for development and education.

The contractor group TQMNW is an example of Nordic co-operation leading to mutual stimulation in one business sector, in co-operation with research and education. The target is to persuade all the parties involved in the Construction sector, together with public owners, private clients, authorities, and all sources of funding to continue to build on the foundation that has been created, and to continue with new co-operative projects. The Construction sectors in the Nordic countries have much in common, they are similar and easy to survey, so that all countries can benefit from direct contact. This may give a solid advantage whilst facing international competition.

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Appendix 1

TQM, definition and interpretation

Total Quality Management - TQM - as defined in the vocabulary ISO/DIS 8402:1994

1) An approach to the management of an organisation,
2) ... focused on quality, based on the participation of all its members
3) ... and aiming at long term success through customer satisfaction and benefits to the members of the organisation and to society in general.

TQM The Nordic Way - interpretation for contractors

1) An approach to the management of an organisation

All managers at all levels should stimulate their employees to continuous improvements, since they encourage all their employees to participate and co-operate. The managers should commit themselves through their leadership, their management of and participation in improvement work, and through their example of personal behaviour.

The strategic management of the company shoul be flexible, and be able to tackle sudden changes such as conjunctures, alterations in market and local conditions, and able if necessary, to adapt the business philosophies, politics and goals to meet such changes.

2) ... focused on quality, based on the participation of all its members

Our guiding principle is that the right quality is to be achieved by preventive action. Supervision, and following up of deviations are aids to improvement. All employees are to recognise their own responsibility, know what is expected of them, and be able to inspect and improve their own performance. The company should maintain a high level of communication, with open access to data and information whenever needed.

All employees should be able to identify both their "internal" as well as their "external" customers, and compare their own production with the needs and requirements of these.

The company regards its suppliers as fellow contributors to the building process. In a project context, efforts are made to stimulate improvements as much for the whole as for each individual party. In addition to evaluating and selecting partners in the process of supply development, the company must also assess how satisfied the suppliers are with the company as a customer.

All employees should understand how they can contribute to the improvements, and should keep an observant eye on the quality of their products or services, activities and goals. This applies to the company as a whole, to the management of projects, and to the work on the individual building sites.

The company should encourage employees to come forward with their ideas of what should be improved and how. The company should actively pursue such suggestions, and follow them up with priorities and execution. The improvement measures are worked into an on-going plan of action. The managers should assign responsibility and resources, set deadlines, and periodically monitor the progress. Employees should participate in the systematic development and establishment of improvements. As many activities as possible should have goals that can be measured.

3) **... and aiming at long term success through customer satisfaction and benefits to the members of the organisation and to society in general.**

The company's most important standard of comparison is the satisfaction of its customers, both customers and end users. Therefore our company and all our employees are always aware of the customer: who he is, and what are his requirements and expectations. The goal is that we should fulfil these expectations 100%, and this is checked with the customer both during and after the process.

The company regards the health, safety, and work environment of its employees as an integral part of the quality concept. This should be integrated in all sections and at all levels of the organisation. Furthermore, the company ensures continuous development of the competence (read: "quality") of its employees though training and information. The management follows up the employees at all levels. Health, work environment and safety are continuously monitored, and improvement measures are incorporated in the company's total plan of action.

The company should comply with the demands and duties required by society, with particular attention to all environmental considerations.

Total Quality Management should reduce the costs, and both short term improvements and better long term profitability should be documented. Total Quality Management should increase the company's ability to compete.

Appendix 2

A Survey on the contents of 20 Quality Plans for design and production

The survey includes 20 Quality Plans from 10 countries: Belgium, Denmark, Finland, Holland, Italy, Japan, Norway, Great Britain, Sweden and Germany. Most plans were provided by general contracting firms, but a few were obtained from design offices (see p. 41). All the lists of contents have been collected into one document, and then all overlapping or repeated topics have been removed. The remaining themes are included in the following list.

Most of the themes in the survey are common for all phases of the building process. The rest are unique for either design or for production. These are mixed up in this survey, since they have been categorised into 10 aspects of management that reflect the management cycle of planning, producing, inspecting and correcting (see also *Fig. 4* in the report).

-0 Universal

Project survey, goals, policy, management plan

Title page with document data and example numbers. List of contents and appendixes, references
Preface with responsibility assignment for plan (drawing up, checking, approving/signing, updating)
Company's/President's vision/policy, deployment
Annual programmes, monitoring, priority giving
Project identification (customer, project name/ case no., place, start and delivery dates)
Customer, client, designers, addresses
Contract references. Brief description of contract form
Scope of task. Project/task description. Brief description of construction object, data. Location plan
Project goals and policy, customers', company's internal
Summary of QA-system for project, scope, validity
Evaluation of degree of difficulty of project, scope of Quality Plan, quality goals, size, tight schedule. Level of skill/experience of employee/work force, customer requirements of quality management
Drawing up of quality plan: objectives, project data, project organisation, quality inspection schedule, co-ordination with suppliers' quality systems, co-ordination with subcontractors' quality plan, co-ordination with customer and total project, project review/construction site, construction site inspection, meeting schedule, audits, information flow, client's special wishes, preparation and administration of construction location, work environment, surrounding environment
Maintenance of Quality Plan, responsibility assignment, time limits (milestones), updating deadlines, edition identification, distribution methods, distribution key, register of editions
Determination of other quality assurance measures, production phase: safety, review of project documents delivered to the construction site, delivery schedule, purchasing agreements, production management, production sequence, conditions for production start, cable plans
HES: Health, work environment, safety, internal monitoring system, environmental management system. Safety management, review of construction documents. Evaluation of own safety plan.
Procedures for prevention of nonconformities and accidents, monitoring of design and production
Building authorities inspection requirements, self inspection system in project
Drawing up of procedures/check lists (responsibility assignment, work sequence, approval, use, overview)
Quality Plan, assembly. Form for content, responsibility assignment, planned and actual dates of execution per inspection period
Quality Plan: attachments, appendixes and written aids. List of forms and quality registrations
QA-system, terminology, explanation of terms in Quality Plan
Company's production management system: minimum level
Company's quality system, relationship to ISO 9001

-1 Organisation

Overview, functions, post description, responsibility, authority, authorisation

Description of organisation, overview
Organisation plan/schedule, contact flow lines, team names including the representatives of the various parties, inspectors, etc.
Functions/posts/jobs, responsibility assignment, authority (power of authority), course of decision making, signature list, content/tasks, description/instructions, flow charts/matrixes
Document extract for HES and fire protection, including co-ordination (if demanded by contract)
Document extract for QA (if demanded by contract)

-2 Communication

Control of document flow and meeting schedules

Market analysis, information on projects, strategy conferences, selection of projects
Communication overview (addresses, etc.) contact list for all project participants
Plan for information to outside: media, neighbours, etc.
On-site approvals required
List of necessary literature for project
Document system for project, type of document, computer system
Document design, identification code
Document control, plan/responsibility assignment for handling, reception, inspection, filing, distribution, calling in, destruction
Registration, storage, duration
Office routines: common filing system, filing key, project file, registration and filing, resp. assignment
Correspondence in and out, distribution, copy matrix
Establishment of file for one set of all documents. Inventory of valid project documents
Storage of tender documents. Storage of updated drawing lists
Filing system for drawings. Drawing status, distribution key
Handling of drawings during design, and on site
Monitoring system to ensure that only currently valid documents are in use
Reporting system/reporting flow lines, (reports, progress, performance)
Customer communication system. Reports to customer. Customer approval
Authority approval, reports to authorities, labour inspection
Final report- error free
Type and frequency of meetings, overview (periodical meetings, annual, monthly, weekly, at the start of each day, before going home each day, or whatever), participants, standard agenda, minutes
System/model for meetings, inspections, reports, minutes
Regular meetings: customer/ project manager, project manager/joint venture, project manager/subcontractors

-3 Requirements

Customer/authorities, product/service, contract, changes, understanding

Company requirements/project goals
Document requirements, document lists, distribution keys
The project's/customer's objectives/requirements/needs, programme requirements, increasing concretisation
Start documentation (contract, project specifications, programme, norms and standard specifications)
Basis and conditions for design
Customer's requirements, drawings/specifications, lists of what is to be delivered/handed over
Project requirements: national and local public authorities
Inspection of neighbouring properties
HES, environmental requirements and considerations
Contract review, contract comments, list of terms of contract
Contract negotiations, contract
Standard technical solutions.
Handling of alterations of contract terms/documents/drawings/descriptions. Change orders, changes, additions and removals, notification of requirements from suppliers
Important factors: conditions for insurance, guarantees, financing
Risk analysis - Failure Mode/causes, Effect Analysis (FMEA), Project review, building-engineering evaluation, risk, execution. Quality critical design work, purchasing and production
Setting of quality goals for construction site, customer's/authorities'/company's requirements and expectations. Definition of quality performance indicators and setting targets
Consultation with customer, authorities, design team and suppliers on fulfilment of requirements/expectations and necessary co-ordination of plans. Project review meeting with, among others, customer to clarify all assumptions and requirements (e.g. construction start meeting)

-4 Resources

Personnel, machines, equipment, competence, development/maintenance, deployment

HES, safety philosophy, internal inspection in the company (co-ordination with project)
Resource plans (from contract review)
Personnel/team/man power deployment plan
Personnel record, updating of training and special experience
Competence requirements for tasks, training schedule/measures for project, documentation
Employer/employee relationships, agreements
Appointment and introduction to work site
Computer equipment, installation and guidance
Materials/equipment plan, deployment
Materials/equipment administration, dispatch, registration, maintenance
Measuring, test and inspection instruments, lists, user instructions
Calibrating, testing and inspection descriptions and tolerances
Responsibility for administration and maintenance

-5 Purchasing

Policy, needs, choice of supplier, purchasing, ordering, reception, nonconformity

Purchasing policy, purchasing plan, company level
Framework agreements for purchasing
Supplier/subcontractor, overview, approval
Requirements of sub-contractor, suppliers and consultants/sub-consultants
Requirements of designer's quality system, quality assurance of sub-contractor, supplier and consultants in invitation to tender/on ordering
Evaluation of suppliers' sub-contractors, material and element suppliers, machine/equipment suppliers, pre-qualification
Choosing of suppliers
Purchasing plan
Material demands, product specifications
Invitations, offer/tender evaluation
Invitations to tender, reception of tenders, opening of tender
Clarification meetings, contract negotiation meetings
Review with sub-contractor of quality, quality assurance agreements.
Right to inspection at production site
Contracting, contract signing (Standard)
Contract document of purchasing of design work
Purchasing and material control. Agreements. Purchasing and delivery schedule, with cancelling forms.
Requisitions
Co-ordination of purchasing and inspection. Supplier inspection
Criteria for approval of deliveries
External inspections
Company inspections, tests, and documentation of suppliers' fulfilment of requirements
Measures dealing with suppliers without satisfactory quality assurance
Control of sub-contractors
Delivery, result, following up
Reception/storage/transport (on site), reception control, labelling inspection, labelling of materials
Handling of materials at the work site, instructions, information, inspection
Dealing with nonconforming products, labelling, reporting
Inspection of stored products
Clarification of responsibility and risk as regards deliveries/materials from the customer, handling, inspection, treatment of nonconformities, complaints, responsible for registration
Concluding orders

-6 Time

Periodical schedules (annual, monthly), phase schedules (design, production), disciplinary schedules, monitoring

Annual plans for corporate business activities, project record
Time schedule for entire project, main work schedule, division into phases
Total schedules for materials/equipment, personnel, drawings, periodical schedule
On-going weekly, or two-weekly schedules
Schedules, delivery date, milestone dates, tasks, interrelations/interfaces, critical phases. Important quality influencing activities in the schedule
Activity planning and monitoring
Project planning, verification
Monthly progress report. Progress monitoring
Schedule from ordering to construction start
Design schedule, with delivery schedule for drawings, calculations, specifications
Documentation of production planning, assignment of responsibility for drawing up, production schedule (Power-Project)
Work schedule for foundations, building structure, internal work etc.
Work schedule for sub-contractors
Schedule for final presentation
Schedule for starting up and final testing

-7 Economy

Calculations, budget, accounts, reports, invoices

Calculations, increasing accuracy, offer, tender, production calculations, resource lists
Financing plan, budget for liquid assets
Operations budget, phase budget, execution budget
Wages agreements, piecework agreements, registration of work hours, quantity measurements/ calculations
Extra work, cost reimbursement, attesting
Cost inspection, monthly reports, economic reports, cost monitoring, project status report, project monitoring, Project accounts
Insurance
Settlement, regulation of costs, inventory of extra work, settlement of additions/deductions
Final invoices to customer, deductions
Handling of invoices, delivery notes, coding, etc.

-8 Production

Method preparations, inspection schedule, execution, inspection, nonconformity, corrective actions, audits, delivery

Project review, levels, steps
Main work schedule: introduction, requirements, other framework conditions
Review of project documents (work basis)
Assignment of responsibility for quality issues
Flow chart for phases, code references to procedures
Define limited tasks with work description/preparation, time limits
Special HES measures. Safety plan for construction plant, review/verification, sign-posting, escape routes, storage/securing
Handling of waste, clearing, cleaning
Relevant procedures regarding quality, especially work procedures
Description of statistical methods to be used in tests
Project documents for design. Concept, basic plan, basic design, detail design
Co-ordination procedures for design, scrutiny and distribution, design schedule, drawing delivery schedule, lists of interfaces between designers
Design meetings, minutes
Design, work drawings (internal plan, external plan, drawing lists, assignment schedule)
Design review
Planning of integrated CAD
Instructions from suppliers on use of materials
Delivery of project plans and review with contractor
Production preparations. Planning system, choice of methods, start meetings: Planning, work preparation, work schedule
Construction start, internal project review, check list for construction start

-8 Production

Method preparations, inspection schedule, execution, inspection, nonconformity, corrective actions, audits, delivery

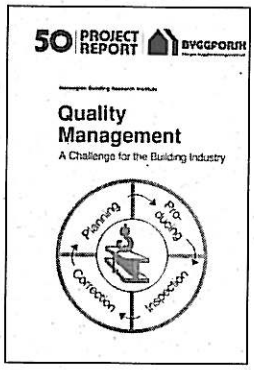
Execution (site management manual)
Mobilisation schedule. Rigging up on site, Deployment of site area, rigging plan. Preparations, on-site inspection
Formwork plan, detailed plan
Production permission, internal company requirements for approved plans
Building meeting, work site/construction site meetings, information meeting, organisation
Building start meeting, preparation for production
Project information meeting for professional workers
Work review before start of new tasks, documentation
Improvement tasks, quality circle, inclusion of sub-contractors, measurement of results
Co-ordination of installations
Project review, start meeting with sub-contractors
Information to domestic and nominated subcontractors on company quality assurance
Supervision plans and reports, Project monitoring, Site journal, diary
Identification of materials used, and placement
Inspection schedule, overview/sub-division into project phases (programming, design, production, handing over)
Inspection schedule, overview/sub-division within phases (functional areas, trades, production elements: foundation, structures, installation) per supplier/sub-contractor
Inspection schedule, what (specifications, critical factors, priorities), requirements (contract, regulations, standards, interfaces to and from), how (procedures, measurement/test conditions), who (self, superior, external, "next" customer), when, documentation (check lists)
Exploratory site survey, site visits, evaluations
Quality surveillance plans/quality surveillance
Safety surveillance plans/safety surveillance
Inspection documentation, check lists, photos, samples, handling (storage, delivery)
Inspection and test status, labelling (drawings, constructions, installations)
Self inspection documentation, as demanded by Planning and Building Law
Handling of nonconformities (errors and deficiencies in relation to contract terms or project description),
Handling of complaints (date, description, reason, measure, approval), following up
Accident reporting. Reporting of damage on the construction site
Corrective action, following up, prevention of re-occurrence
Quality system audit (internal/external), plans, before project start, sales start, construction start, delivery, final report
Final documentation (updated programme, project specification, drawings, Project Administration Book, building notification, revised calculations, budget, annual costs calculations, work schedule, project review report, quality plan for production phase)
Planning of project documentation, handling of "as built" documents
"As built" file to customer, inspection, nonconformity, protocols, quality audits. Original documents to customer
Handing over, operating instructions, operating schedules. Instructions for use of building, maintenance card, manual for operating and maintenance, operating and maintenance instructions
Finishing phase: preliminary inspection, inspection record, co-ordinated function tests, final inspection and testing, final survey, handing over
Plan for handing over. Handing over and approval of sections, internal handing over, external handing over/delivery
Schedule for building authorities' final inspection
Clearing out
Guarantee. Error free guarantee for main building elements (5-7-10 years)
Complaints, guarantee period, deterioration book, final report

-9 Practical experience

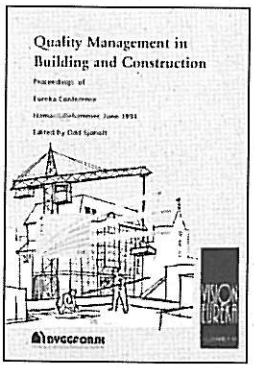
Evaluation, transfer, exploitation, filing, concluding

Retrospective calculations, cost analysis
Quality records (check lists, forms, audit reports, nonconformity register)
Evaluation of customer satisfaction
Evaluation of project as a whole, final report, concluding meeting to collect/discuss/concretise practical experience gained
Transfer/feedback of experience from project to basic organisation
Clearing up the project files, local and central

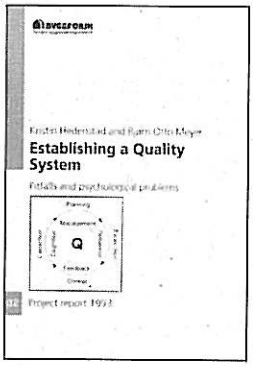
Publications on Construction Management and Quality Control



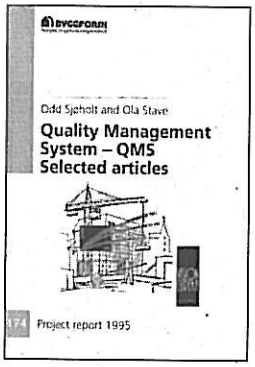
Project Report 50
Quality Management - A challenge for the Building Industry
1989. Price NOK 195,-
This report is based mainly on the results and practical experience gained from quality management projects that the Norwegian Building Research Institute has been involved in. The basic elements of the *Quality Management System - QMS* - are described, including a system structure, a five step implementation process and a co-operation model for company groups.



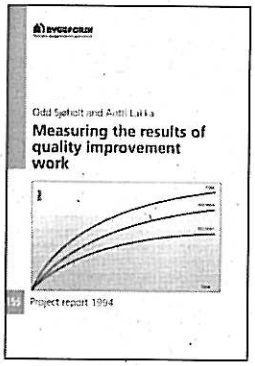
Proceedings from the EUREKA conference Hamar/Lillehammer 1994
Quality Management in Building and Construction. 1994. Collection of 80 articles. Price NOK 525,-
About 160 persons from 30 countries participated in the three days conference for building and construction. The conference has been widely recognized as a great success. The proceedings in particular were highly appreciated.



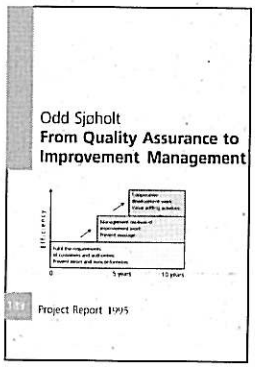
Project Report 132
Establishing a Quality System - Pitfalls and Psychological Problems
Kristin Hedenstad and Bjørn Otto Meyer. 1993. Price NOK 195,-
This project report is a presentation of some of the findings in a thesis, on the psychological aspects of introducing and establishing improvements within a company. The study is a useful evaluation of the *Quality Managements System - QMS* - emphasising the importance of a genuine living quality system opposed to «paper work systems».



Project Report 174
Quality Management System - QMS Selected articles
1995. Price NOK 195,-
This report is a collection of 10 articles on practical adoption of the Quality Management System - QMS, tailored for the building and construction industry. These articles are also included in the proceedings from the EUREKA conference in Hamar/ Lillehammer 1994.



Project Report 155
Measuring the Results of Quality Improvement Work
Odd Sjøholt and Antti Lakka.1994. Price NOK 195,-
The report is a result of a collaboration between Nordic researchers and representatives of 12 Nordic contractors. The report contains examples on measuring nonconformities and waste, including results of measurements from a selection of companies. The report also discusses experiences with internal assessments based on Quality Award Criteria.



Project Report 189
From Quality Assurance to Improvement Management
Odd Sjøholt. 1995. Price NOK 195,-
This report is a result of collaboration between Nordic researchers and representatives of 11 Nordic contractors. The report indicates how quality improvement work can be established step by step in a company. The actual ISO standards related to quality are reviewed in a wider context. The new set of quality words is examined with criticism, recommending to focus on the basic terminology for organisation, management and control.

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