QUALITY IN CONSTRUCTION

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Quality/quality management

- What is quality?
  - fitness for purpose
  - Conformance to requirements
  - perceptual, conditional and somewhat subjective attribute and may be understood differently by different people
  - „must-be quality”: fitness for use and „attractive quality”: meeting or exceeding customers' expectations
  - Number of defects per million opportunities

Quality/quality management

- What is quality management?
  - It does not aim to assure good quality, but rather to ensure that an organization or product is consistent.
  - It has four main components:
    - quality planning,
    - quality control,
    - quality assurance,
    - quality improvement.
  - Principles:
    - meeting customer requirements,
    - leadership and involvement of people,
    - understanding and managing all interrelated processes as a system,
    - continual improvement
    - decisions are always based on the data analysis and information

Quality/quality management

Quality in the construction industry

- Quality refers to products or services
- Quality management refers to processes
  - Production of material or other products (industrial processes)
  - Using these materials or other products in construction projects

Regulation

- Council Directive 89/106/EEC relating to construction products
  - The essential requirements do not apply directly to the products themselves, but are broad functional requirements which apply to the construction works in which the products are to be incorporated.
  - Definition: 'construction product' means any product which is produced for incorporation in a permanent manner in construction works, including both buildings and civil engineering works
  - Harmonised standards
  - European technical approval
  - Attestation of conformity

Regulation

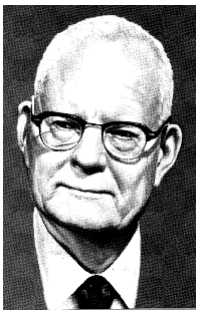
- Council Directive 89/106/EEC relating to construction products - Annexes
  - Essential requirements
    - Mechanical resistance and stability
    - Safety in case of fire
    - Hygiene, health and the environment
    - Safety in use
    - Protection against noise
    - Energy economy and heat retention
  - European technical approval
  - Attestation of conformity with technical specifications
  - Approval of testing laboratories, inspection bodies and certification bodies

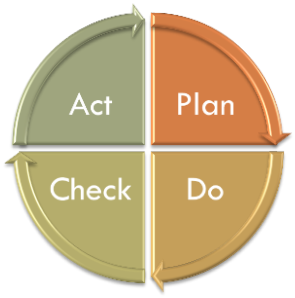
Quality management

- Short history
  - Middle age: Guilds
  - Frederick W. Taylor (1856 –1915) - improve industrial efficiency (decreasing quality)
  - Mass production: inspectors
  - Walter A. Shewhart (1891 - 1967) statistical quality control – process quality control
  - WW2 – USA – importance of quality

Quality management

- Europe 1920-40 quality check
- Japan, 1950 W. Edwards Deming (1900-1993) and Joseph M. Juran (1904 – 2008) – TQ strategy
  - Deming cycle PDCA





Quality management

- Japan, 1950 W. Edwards Deming (1900-1993) and Joseph M. Juran (1904 – 2008) – TQ strategy
  - Deming's 14 key principles :
    1. Create constancy of purpose toward improvement of product and service, with the aim to become competitive, stay in business and to provide jobs.
    2. Adopt the new philosophy.
    3. Cease dependence on inspection to achieve quality. Eliminate the need for massive inspection by building quality into the product in the first place.
    4. End the practice of awarding business on the basis of a price tag. Instead, minimize total cost.

Quality management

- Japan, 1950 W. Edwards Deming (1900-1993) and Joseph M. Juran (1904 – 2008) – TQ strategy
  - Deming's 14 key principles :
    5. Improve constantly and forever the system of production and service, to improve quality and productivity, and thus constantly decrease costs.
    6. Institute training on the job.
    7. Institute leadership. The aim of supervision should be to help people and machines and gadgets do a better job.
    8. Drive out fear, so that everyone may work effectively for the company.

Quality management

- Japan, 1950 W. Edwards Deming (1900-1993) and Joseph M. Juran (1904 – 2008) – TQ strategy
  - Deming's 14 key principles :
    9. Break down barriers between departments.
    10. Eliminate slogans, exhortations, and targets for the work force asking for zero defects and new levels of productivity.
    11. Eliminate work standards (quotas) on the factory floor. Eliminate management by objective.
    12. Remove barriers that rob people of their right to pride of workmanship.
    13. Institute a vigorous program of education and self-improvement.
    14. Put everybody in the company to work to accomplish the transformation. The transformation is everybody's job.

Quality management

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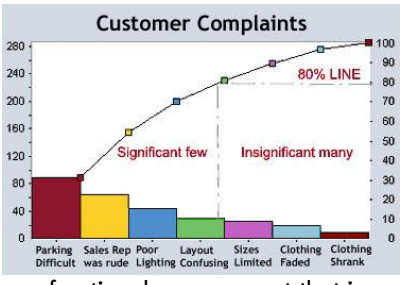


  - Applying the Pareto principle to quality issues
  - Focus on managing for quality
  - Juran's trilogy: an approach to cross-functional management that is composed of three managerial processes: quality planning, quality control and quality improvement.

Quality management

- Europe 1979 – BS 5750 Standards on quality management, based on Department of Defence MIL-Q-9858 standard (USA)
- 1987 – ISO 9000 series of standards reviewed several times since then
- 1996 – ISO 16000 series of standards - Environmental management standards
- Nowadays: integrated systems, harmonising standards and systems, total quality management approaches

ISO 9000 standards

- ISO 9001:2008 Quality management systems — Requirements
- ISO 9000:2005 Quality management systems — Fundamentals and vocabulary
- ISO 9004:2009 Managing for the sustained success of an organization — A quality management approach
- The ISO 9001 standard is generalised and abstract, it contains business management guidelines.

ISO 9000 standards

- Rewiews of ISO 9000
  - **1987**: ISO 9000:1987 had the same structure as the BS 5750, with three 'models' for quality management systems:
    - ISO 9001:1987 – quality assurance in design, development, production, installation, and servicing
    - ISO 9002:1987 – quality assurance in production, installation, and servicing
    - ISO 9003:1987 – quality assurance in final inspection and test
  - **1994**: ISO 9000:1994 emphasized quality assurance via preventive actions, instead of just checking final product, and continued to require evidence of compliance with documented procedures.

ISO 9000 standards

- **2000**: ISO 9001:2000 combined the three standards—9001, 9002, and 9003—into one, called 9001. It placed the concept of process management front and centre. It demanded involvement by upper executives in order to integrate quality into the business system. Another goal was to improve effectiveness via process performance metrics: numerical measurement of the effectiveness of tasks and activities.
- **2008**: ISO 9001:2008 basically re-narrates ISO 9001:2000. It only introduced clarifications to the existing requirements of ISO 9001:2000 and some changes intended to improve consistency with ISO 14001:2004.

ISO 9000 standards

- Main points of ISO 9001
  - The quality policy is a formal statement from management, linked to the business and marketing plan and to customer needs. The quality policy is understood and followed at all levels and by all employees.
  - The business makes decisions about the quality system based on recorded data.
  - The quality system is regularly audited and evaluated for conformance and effectiveness.
  - Records show how and where raw materials and products were processed to allow products and problems to be traced to the source.

ISO 9000 standards

- The business determines customer requirements.
- The business has created systems for communicating with customers about product information, inquiries, contracts, orders, feedback, and complaints.
- When developing new products, the business plans the stages of development, with appropriate testing at each stage. It tests and documents whether the product meets design requirements, regulatory requirements, and user needs.
- The business regularly reviews performance through internal audits and meetings. It has a documented procedure for internal audits.

ISO 9000 standards

- The business deals with past problems and potential problems. It keeps records of these activities and the resulting decisions, and monitors their effectiveness. There are documented procedures for dealing with actual and potential problems involving suppliers, customers, or internal problems.
- The business
  - makes sure no one uses a bad product,
  - determines what to do with a bad product,
  - deals with the root cause of problems,
  - keeps records to use as a tool to improve the system.

Quality management

- Methods of quality improvement
  - PDCA — plan, do, check, act cycle for quality control purposes.
  - 6σ, Six Sigma combines established methods such as statistical process control, design of experiments (DMAIC method: define, measure, analyze, improve, control) and failure mode and effects analysis (FMEA) in an overall framework.
  - TQM — total quality management is a management strategy aimed at embedding awareness of quality in all organizational processes.
  - ISO 10006:2003, Quality management systems - Guidelines for quality management in projects

Quality management in construction

- Building (i.e. using building materials and other products) is different from other industrial processes, because:
  - A construction project is always unique (different place/building/team…)
  - A construction project has relatively high costs – the product (building) has longer lifespan
  - The product (building) can not be moved – the „factory" – producing equipment is moved to the site
  - Processes take place outside – effects of weather
  - Built-in defects are complicated to correct

Quality management in construction

- A construction project has lots of processes, needs lots of professions
- Changing priorities during the project:
  - Price in planning phase
  - Deadline in construction phase
  - Quality at handover
- Processes are changed/developed during the construction

Quality management in construction

- Customer needs:
  - Functional, economical, technical, aesthetical etc. requirements of the client
  - All the needs of the users – known/unknown during he project
  - Social claims
  - Legal prescriptions (local and global)

Quality management in construction

- According to the ISO 9000 standards, all projects should have their own audited quality management systems.
- If the main contractor (prime/general contractor) has an audited QM system, then all the relating parts can be used in the projects.
- Every project has to have its own Project Quality Management System.
- The project manager's task is to decide on the project organisation, and the PQMS.

Quality management in construction

- Quality aims have to defined, and understood by all participants
- The system of responsibilities has to be defined for all of the processes.
- Quality expectations have to be fixed – esp. for significant technologies.
- Methods and frequency of quality control have to be predefined.
- Subcontractors have to know and accept quality aims and quality plans related to their processes.

Quality management in construction

- Selecting subcontractors
  - Evaluation criteria have to be defined
  - According to ISO 9000 – there should be an updated list of subcontractors, suppliers, that contains quality evaluation for former co-operations
  - Factors can be:
    - Quality
    - Keeping deadlines
    - Being reliable
    - Price
  - Before contracting, new sub-contractors have to be audited
  - After finishing the job, sub-contractors have to be evaluated.

Fire protection

- Council Directive 89/106/EEC relating to construction products, Annex 1. point 2.: Fire protection
- The construction works must be designed and built in such a way that in the event of an outbreak of fire:
  - the load-bearing capacity of the construction can be assumed for a specific period of time;
  - the generation and spread of fire and smoke within the works are limited;
  - the spread of fire to neighbouring construction works is limited;
  - occupants can leave the works or be rescued by other means;
  - the safety of rescue teams is taken into consideration.

Fire protection

- The classification or availability of the structures, those classification can not be defined squarely (containing more different layers form fire protection aspects) should be considered based on the fire protection levels, and using data from reaction to fire tests.
- *MSZ EN 1364 1-6 series:* Fire resistance tests for construction elements

Fire protection

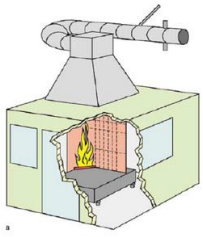
- 9/2008 ÖTM decree: National Fire Protection Regulation
- Attestation of conformity by the assigned organisation
  - For building materials and elements
  - For active fire protection materials and elements
- It can be based on a technical specification, like:
  - ETA
  - ÉME
  - The data should be compared to national requirements

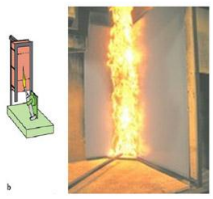
Fire protection

- EN13501-1:2007:Fire classification of construction products and building elements
- The classes is EN 13501-1 actively consider the parameters like characteristics of flame spread, extend to include the rate of heat release, heat release, toxicity of smoke density and combustion result etc..
- EN 13501-1 also provides a number of test methods not only considering the actual fire scene, but also considering the end use of the material, which is more practical representation.

Fire protection

- EN standards for reaction to fire tests:
  - EN 13823: 2002: The Single Burning Item
  - EN ISO 11925-2: Ignitability of building products subjected to direct impingement of flame





Fire protection

- Flammability classification
  - Classification for Construction products excluding flooring : A1, A2, B, C, D, E, F
  - Classification for floorings: $A1_{fl}$, $A2_{fl}$, B_{fl}, C_{fl}, D_{fl}, E_{fl}, F_{fl}
- Burning droplets: d0, d1, d2
  - d0 = no droplets within 600 seconds
  - d1 = droplet form within 600 seconds but do not burn for more than 10 seconds
  - d2 = Not as d0 or d1
- Smoke: s1, s2, s3
  - s1 = little or no smoke generation
  - S2 = medium smoke generation
  - S3 = heavy smoke generation

Fire protection

- Classification of building products in the German construction regulations as compared to the classification of the European standard EN 13501-1 (excluding floor covering)

Building products classification	No smoke	No burning droplets	European class EN 13501-1
Non-combustible building products	✓	✓	A1
	✓	✓	A2 - s1, d0
Building products - hard to burn	✓	✓	B, C - s1, d0
		✓	A2, B, C - s2, d0; A2, B, C - s3, d0
	✓		A2, B, C - s1, d1; A2, B, C - s1, d2
			A2, B, C - s3, d2
Building products - normally burning		✓	D - s1, d0; D - s2, d0; D - s3, d0; E
			D - s1, d1; D - s2, d1; D - s3, d1; D - s1, d2; D - s2, d2; D - s3, d2; E - d2
Building products - easily burning			F

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