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Designing Closed Quality Control Loops For Stable Production Systems

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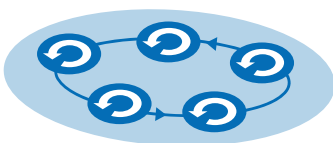


Brief Presentation Of The Research Project

(QC)² - Quantifiable Closed Quality Control

Run-time: 2010-2012

Funding organizations



"It is not the strongest of the species that survives, nor the most intelligent. It is the one that is the most adaptable to change."

~ Clarence Darrow, famous American lawyer

How can companies cope with change caused by...
... **external disturbances** which are swept in by the markets and its customers as well as ...
... **internal disturbances** within entrepreneurial processes?

The holistic project approach is based on the scientific and industrial expertise of production, control and information technology

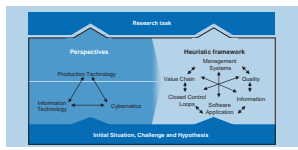
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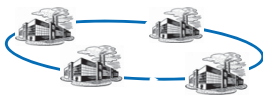
Slide 2

Three Research Institutes Cooperate With SME To Synthesize Scientific And Industrial Research Competences

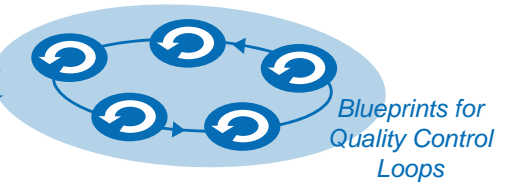
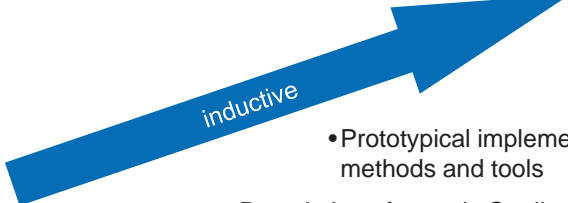
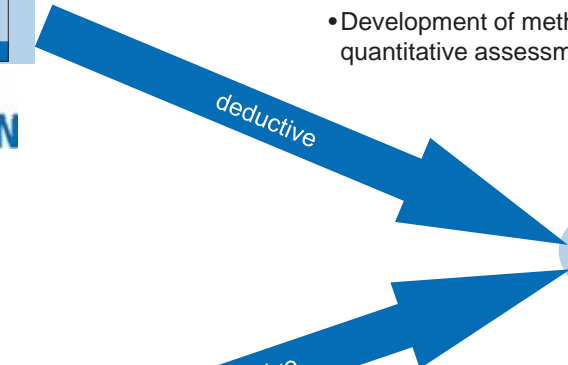
Collaborative Approach



15 SME from Germany and Hungary



- Scientific definition of Quality Control Loops
- Development of a modeling approach for Quality Control Loops
- Development of methodologies for a qualitative and quantitative assessment of Quality Control Loops



- Prototypical implementation and validation of developed methods and tools
- Description of generic Quality Control Loop structures
- Definition of SME's requirements concerning the application of Quality Control Loops

Quality According To ISO 9000 – A Maximization Problem

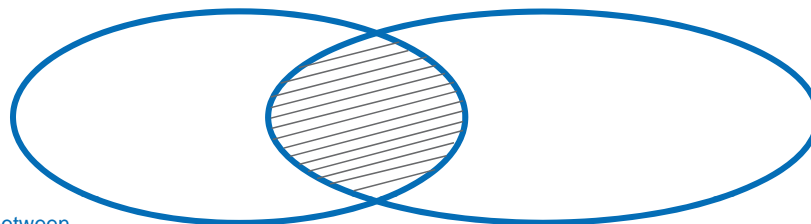
“Quality” ...

degree to which a set of inherent **characteristics** fulfils **requirements**.

Source: ISO 9000

Customer requirements

Product characteristics

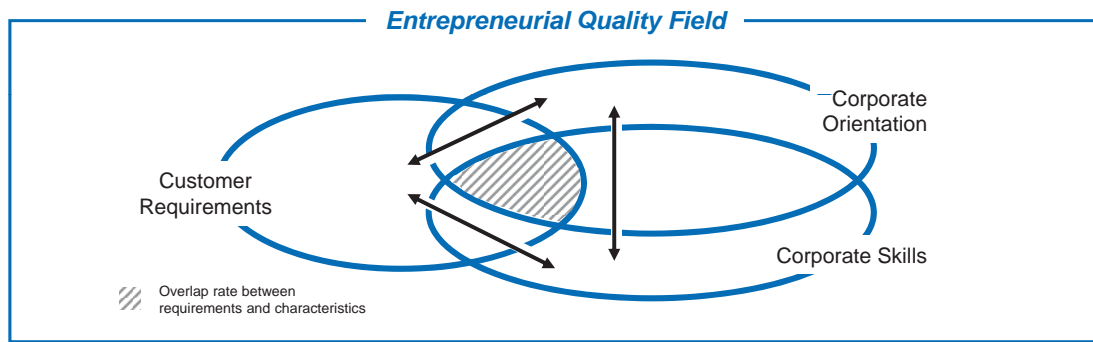


≡ Overlap rate between requirements and characteristics

- **Restriction 1 – Market-sided assumption:** Companies already know or can decide who their customers are and what they want!
- **Restriction 2 – Organizational-sided assumption:** Companies possess all skills that are necessary to operate exactly as their strategies dictates!

→ Companies cannot trust in a unidirectional maximization of quality target parameters, but have to balance their position within the target field considering conflicting target parameters

The Entrepreneurial Quality Philosophy



- All three fields are continuously shifting and changing over time
- Entrepreneurial Quality Management has to plan, monitor, control, and adapt the desired equilibrium within the field of entrepreneurial quality constantly

→ The mechanisms of Quality Control Loops systematically support companies to find an equilibrium within the field of Entrepreneurial Quality

The Aachen Quality Management Model A Framework For Entrepreneurial Structures And Activities

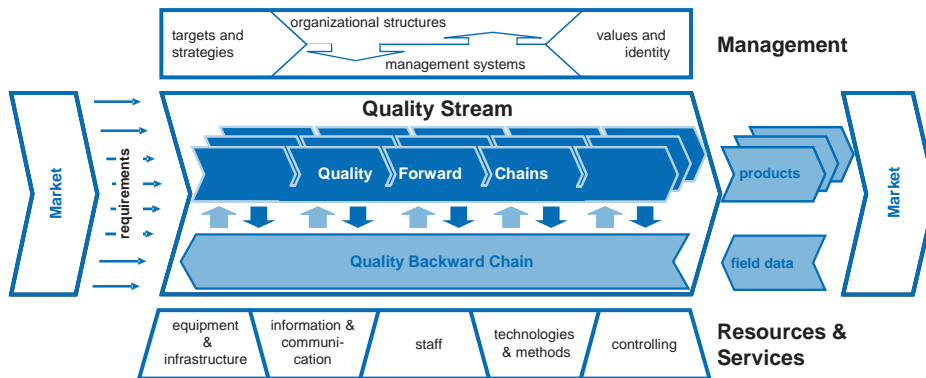


The Aachen Quality Management Model

A Framework For Entrepreneurial Structures And Activities

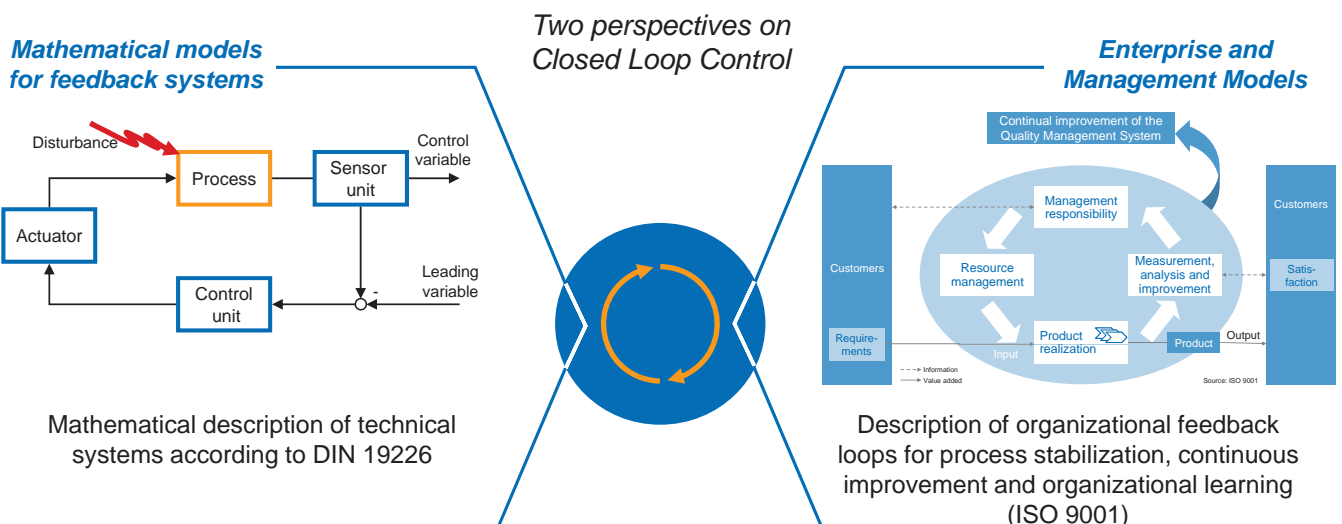
The **Quality Stream** as the unique feature of the model consists of two structural elements:

- The **Quality Forward Chains** include the proactive and preventive measures per product group
- The **Quality Backward Chain** organizes the reactive and corrective actions for all product groups



→ The Aachen Quality Management Model as a framework for quality related structures and tasks

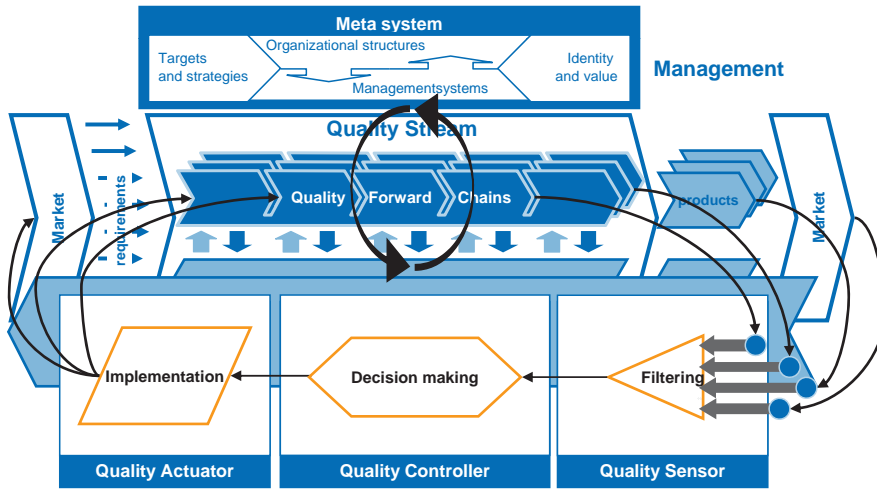
In Order To Cope With External And Internal Disturbances Operational Feedback Mechanisms Are Required



→ Quality Control Loops combine the advantages of both approaches

A First Step Towards The Integration Of Technical And Organizational Feedback Approaches

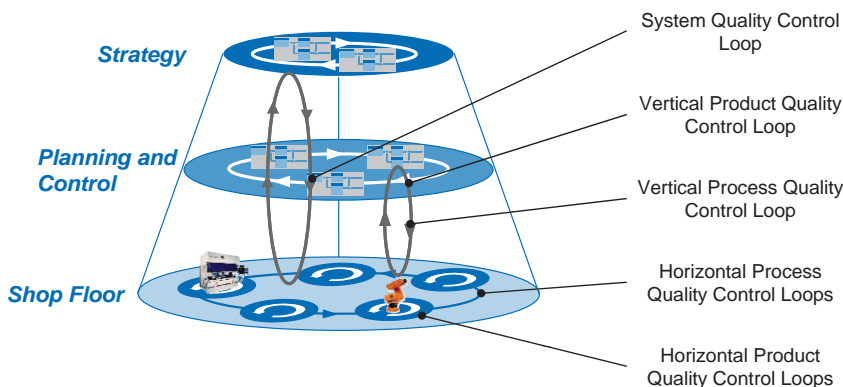
Quality Control Loops within the Aachen Quality Management Model



- **Quality Sensor:**
 - Systematic monitoring and capturing of quality data
 - Data processing and interpretation
 - Filtering and transmission of data and information
 - Detection of deviations
- **Quality Controller:**
 - Analysis of information and comparison to given targets
 - Identification of root causes
 - Definition and selection of measures
 - Adaption of all units within the feedback loop according to changes in policy
- **Quality Actuator:**
 - Coordination and initialization of decided measures
 - Implementation of measures
 - Primary proof of efficiency

→ Quality Control Loops enable enterprises to cope with internal and external disturbances.

Horizontal And Vertical Quality Control Loops On Different Organizational Levels



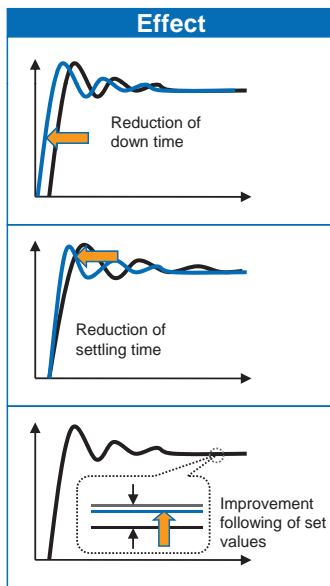
■ Horizontal Control Loops:

- Located within a single organizational level
- Describe how one process is being controlled and how this control loop interacts with other control loops
- E.g. end-of-line inspection on shop floor level

■ Vertical Control Loops:

- Adhere between at least two different organizational levels
- Describe how control loops of lower levels are monitored, controlled and designed
- E.g. management assessment of business processes

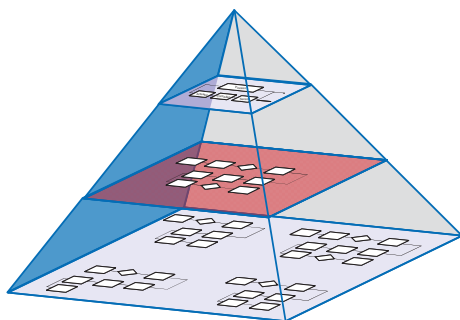
Design Of Quality Control Loops



- Definition of system boundaries
- Analysis and description of controlled system
- Identification of
 - Sensors: „Detect“ and provide data
 - Controllers: decision making, selection of actuators
 - Actuators: affect the controlled system by taking measures (process, product, human)
- Assessment of Quality Control Loops

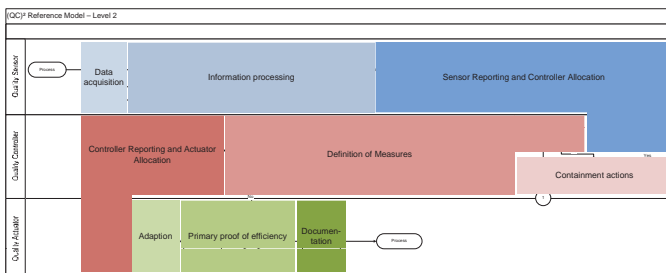
- Lead questions for the analysis of Quality Control Loops
 - Are closed cause-and-effect relationships available?
 - Are control loops interconnected or control loop elements associated redundantly?
 - Are all process steps of the Quality Control Loop accomplished completely, effectively and efficiently?
 - Are all measured variables, control variables and actuating variables described and quantifiable?
 - Are these variables directly related to the objective target of the process chain?
 - Can disturbance variables be considered and dampened in their effect?

Process Reference Model Of Closed Loop Quality Control

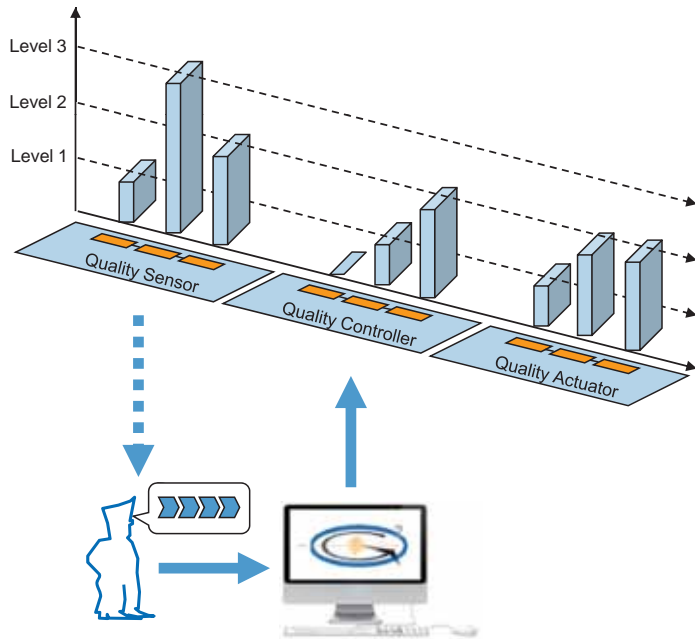


■ The (QC)² Reference Model

- Level 1: General Structure
 - Defines the universal structure of a Quality Control Loop with its three main elements
 - Sensor
 - Controller
 - Actuator
 - Specifies the 9 main phases of closed loop quality control
- Level 2: Detailed Process Steps
 - Generic but detailed description of all required process steps within a Quality Control Loop
 - Enables Companies to identify, describe and optimize the structures of existing Quality Control Loops
 - Accelerates the design of enterprise-individual Quality Control Loops
- Level 3: Tailored blueprints
 - Best Practice Quality Control Loops for selected processes



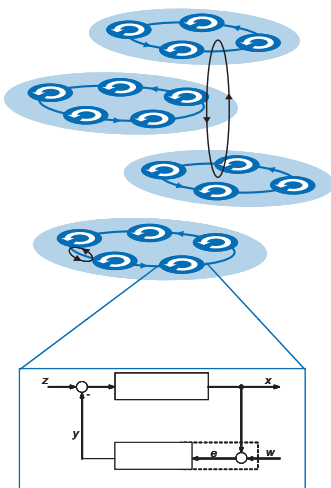
Assessment Of Quality Control Loops



Quality Control Loops are assessed on three levels

- Level 1: Performed
 - Provides a qualitative assessment
 - Evaluates the degree of performance based on a detailed questionnaire (analysis of each process step)
 - Weaknesses in the structure of a Quality Control Loop can be identified
- Level 2: Managed
 - Includes a quantitative assessment
 - Based on KPIs
 - Considers timing parameters, costs and required resources
- Level 3: Established
 - Maturity level of Quality Control
 - Are Quality Control Loops implemented for all main business processes?
 - Are Quality Control Loops analyzed and improved on a regular basis?

Quality Control Loops Are Suitable To Operationalize Required Information Flows For Closing Existing Gaps



Conclusion/ Hypothesis

- Robust and quantifiable Quality Control Loops allow companies to identify, use and distribute needed information
- Complex interactions in value chains can be modeled and combined to closed Quality Control Loops
- Quality control loops describe the interaction of organization, factors of production and information flows with the objective of "controlled quality" including effective and efficient processes and workflows
- Quality is an adjustable value, which is embodied by various parameters and needs to be determined from multiple perspectives. The objective is not to maximize quality but to control it along the value chain
- Independent technical control loops and organizational improvement processes are insufficient for the task of controlling quality

Further steps

- Development and description of blue-prints for quality loops
- Improving the developed hypothesis
- Implementation of the (QC)² reference model and the assessment tool into a software program

→ A sufficient closed Quality Control Loop structure supports companies to stabilize their production systems within the field of Entrepreneurial Quality

Thank you very much for your attention!

Acknowledgement

Thanks to...

