Navigation and Quality of Construction Processes

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Structure

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- **Quality Model and Characteristics**
- **Quality Safeguarding for Construction Processes**
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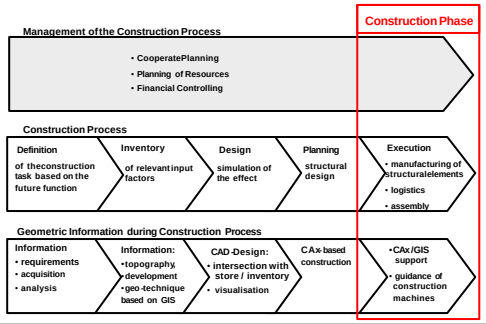
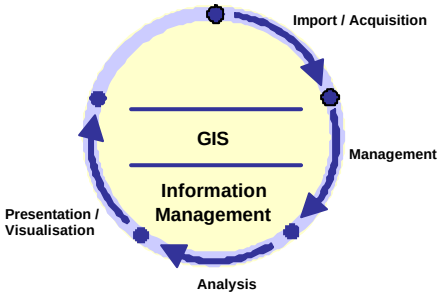
Introduction

- **Current status in construction processes:**
  - frequently the surveyor delivers co-ordinates and other geometric information to the civil engineer
  - the surveyor does not participate at decisions based on his information
- **Higher degree of automation leads to**
  - higher degree of safety requirements
  - more complex construction tasks
- **Requirements:**
  - assured quality for geometric information
  - realtime integration of geometric information into construction processes

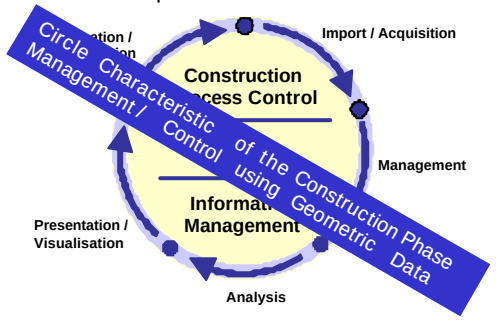
Construction Process and Information Chain



IMAP - Principle

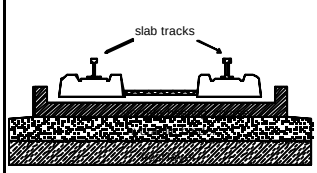


IMAPR – Principle / Construction Circle

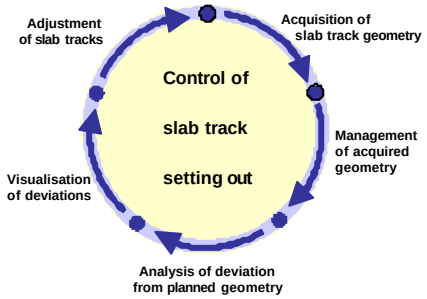


Exemplary Realisation for High-Speed-Tracks

- **Construction phase for high-speed slab tracks „Feste Fahrbahn“ for Köln-Rhein/Main (gravel is replaced by concrete)**
- **Surveying task: Setting out of slab tracks**
- **Adjustment possibility of slab tracks only within some mm**



IMAPR for Slab Track Setting Out



Quality Model and Characteristics

- **Quality characteristics in engineering geodesy:**
  accuracy, reliability, sensitivity, separability.
- **Current relevant quality characteristic in civil engineering:**
  accuracy described by different tolerances.
- **Proposed quality criteria on construction sites:**
  (according to Wiltschko (2004) and various literature about automation in construction)
  reliability (of the equipment),
  availability (of data or systems),
  completeness (of information),
  correctness,
  up-to-dateness,
  level-of-detail.

Lack of a complete quality model for construction processes !

Internal and External Geometry

- **Internal geometry - shape of an object**
- **External geometry - position of an object**

- **Quality (accuracy) parameters have to be assigned to internal resp. external geometry**
- **Quality demands for internal geometry in general higher**

Additional remark

accuracy criteria demand for relationship between given tolerances and determined standard deviations: $s_S \approx 0.2 \cdot T$

Internal and External Geometry for Slab Tracks

- **External geometry 20 mm**
  tolerances with respect to control network near the track
- **Internal geometry** see table
  tolerances with respect to shape of rail tracks (curvature)

internal geometry criteria	tolerances
track gauge	4 mm
transverse inclination	4 mm
ordinate for horizontal component 5 m point distance 150 m point distance	4 mm 20 mm

Outstanding acuracy requirements for internal geometry !

Demand for quality safeguarding integrated into the construction process !

Quality Safeguarding for Construction Processes

Quality assurance comprises
- **a-priori evaluation,**
- **quality measurement and realtime evaluation,**
- **propagation of quality measures,**
- **realtime documentation of results and quality measures.**

Safeguarding measures

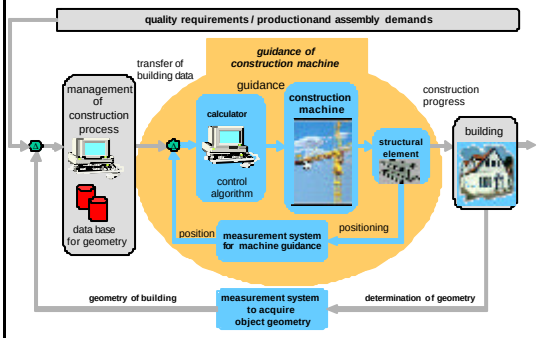
assure that the measured quality is in accordance with the planned quality (a-priori evaluation) !

Quality Safeguarding Integrated into Construction of Slab Tracks

	safeguarding measures	quality characteristic
Quality Assurance	- determination of tachymeter coordinates in control network	- external geometry
	- use of metal pillars for setting out	- external / internal geometry
	- alignment method for setting out	- internal geometry
	- integration of construction circle for realtime control (fig. 4)	- internal geometry
	- realtime documentation of results	- external / internal geometry

Conclusions

- **Demand for a complete quality model including inherent characteristics and parameters**
- **Integration of quality assurance including safeguarding measures into the construction process**
- **Safeguarding measures show positive effects for construction of slab tracks**
- **The IMAP-principle has to be upgraded by the action realisation respectively construction leading to the IMAPR-principle**
- **Construction phase is a construction circle following the IMAPR-principle leading to construction process control and quality driven control circles**



Outlook

- **Navigation of construction processes by geometric information (delivered by the surveyor)**
- **Obtainment of required quality with as less time and cost effort as possible: „design-to-quality“-process**
- **Knowledge about and application of control systems and cybernetics is essential for surveyors to discuss at eye-level with civil engineers**

Participation in decisions of interdisciplinary projects like are construction processes !
The surveyor as decision maker !

Thank you very much for your attention !

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