Evolving Construction Quality Management in Practice

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CONTENT

1. Background
2. Quality Thinking in Construction
3. Evolving Construction Quality Beyond Traditional Practices
4. Conclusion

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Evolving Construction Quality Management in Practice

CHAPTER 1

Background

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Background

A declining industry

Least-improved

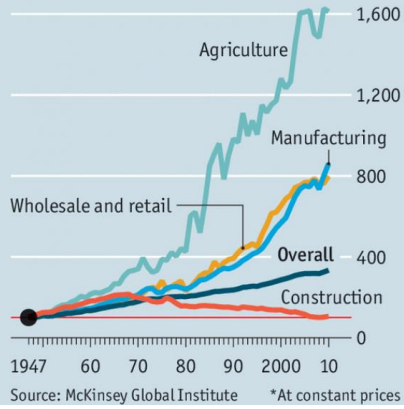
Efficiency eludes the construction industry

- More than 90% of the world's infrastructure projects and either **late** or **over-budget**. In France and Italy, productivity has fallen by one-sixth and in America, it has plunged by half since the late 1960 (The Economist, 2017).
- Competition is fierce, profit margins are thinner, no collaboration, poor workmanship.

The Economist

Unlearning by doing

United States, gross value-added*
Per hour worked, 1947=100

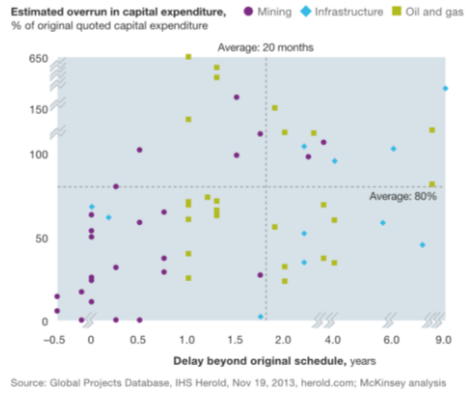


Source: McKinsey Global Institute *At constant prices

Background

A declining industry

- Large construction projects typically take 20% longer to finish than scheduled and are up to 80 percent over budget.
- Financial returns for contractors are often relatively **low** and **volatile**.

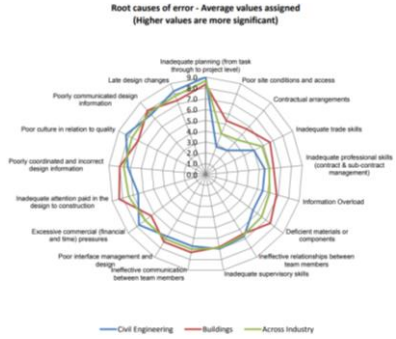


Source: Global Projects Database, IHS Herold, Nov 19, 2013, herold.com; McKinsey analysis

Background

A declining industry

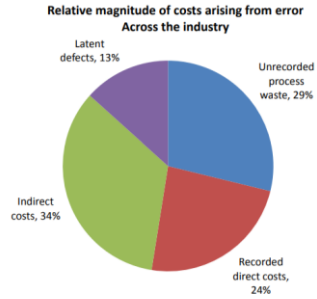
- In GIRI Research Report conducted in 2016 in the UK, 'lack of planning at all levels', 'late design changes' and 'inadequate attention paid in the design to construction' were key root causes of errors.
- Similar findings in another research study in Hong Kong *(Wan, 2010)* revealed that 'poor coordination of processes/ trades' and 'design changes / errors' were critical causes.



Background

A declining industry

- Time taken to **rectify errors** is estimated to be 11% of total working hours allocated for a project and costs to correct errors are more than 6% of production costs.
- **Direct costs** of rework range between 10-15% of contract value and the costs could be even higher as they do not represent **latent and indirect costs** caused by schedule delays, litigation costs and other intangible aspects of poor quality.



Background

A declining industry

- The construction industry in Hong Kong has witnessed a series of incidents and alleged issues related to quality of construction delivery.
- **Noncompliance** works and **corner cutting** scandals including steel bars having been cut short and not screwed into couplers to required depth, and deviation in diaphragm walls and platform slab from specifications in SCL railway project.

Background

A declining industry

- Accusations relating to validity of **control measures** and missing **inspection reports** in rail and bridge infrastructural projects.
- Variations among different project teams in administration of acceptance standards in ensuring compliance of completed works that may be attributable to subjectivity in **interpretation of contract** requirements.

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CHAPTER 2

Quality Thinking in Construction

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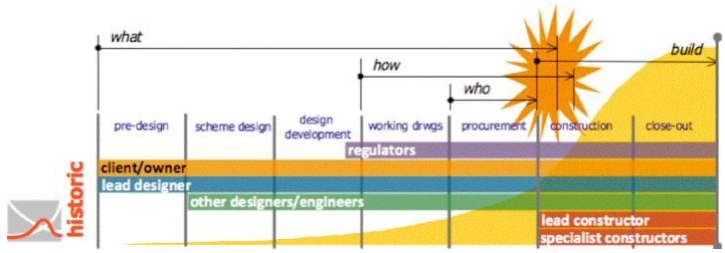
Quality Thinking in Construction

Why conventional project fails ?

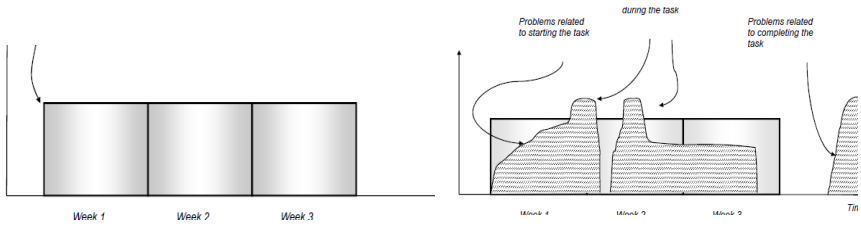
- Projects are always managed by breaking into pieces or activities by using **schedule to push** for work to begin on the earliest start date.
- Control begins with tracking and rests on **thermostat model** and action taken either to speed up or re-sequence activities.
- Reliable release of work from one crew to the next is assumed or ignored.



Quality Thinking in Construction

Why conventional project fails ?

- In construction project, a task should be started after the completion of the preceding task according to the master schedule.
- There are always changes in design, unavailability of resources, materials, information and site access, i.e. **prerequisites** and **preconditions** for task.



Tasks of three weeks in the schedule

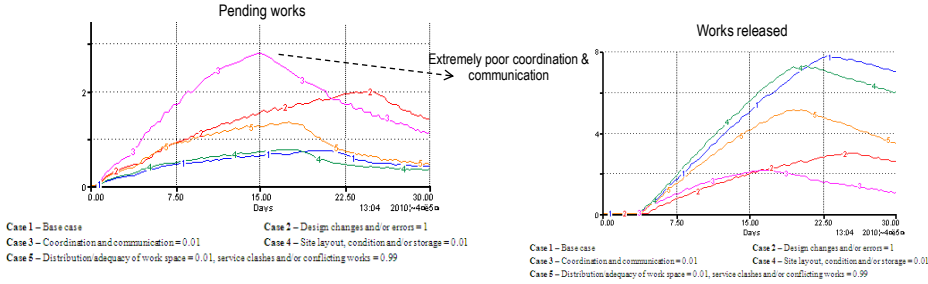
What happens in reality

(Koskela, 2009)

Quality Thinking in Construction

Why conventional project fails ?

- With extremely poor coordination and communication, a large amount of pending works could escalate after starting work.
- Inadequate **preconditions** could arise conflicts at works and design changes or errors are primary sources of rework, i.e. key production waste.

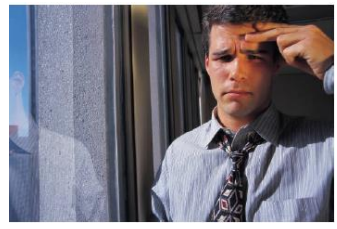


(Wan et al, 2014)

Quality Thinking in Construction

Why conventional project fails ?

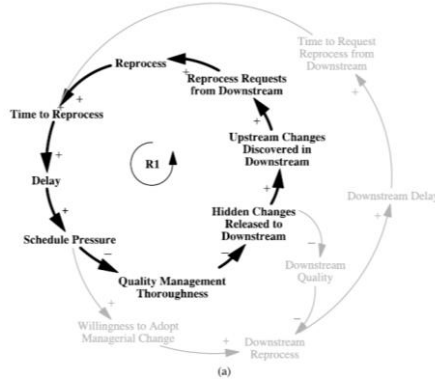
- Projects of poor quality often involve numerous **non-value-adding iterations** that are mainly associated with defective works, rework, design changes, fabrication errors, workmanship and poor coordination.
- Reworks and errors will generate further more works, reworks and errors, and these create more problematic behaviours that often stretch out over the project duration.
- Most non-value-adding iterations, however, can be reduced if they can be **identified in advance** and managed with a well-prepared plan.



Quality Thinking in Construction

Dynamic analysis on project failure

- Quality management thoroughness tends to become lower which can trigger a reinforcing feedback loop when there is **schedule pressure**, **hidden upstream problems** and **poor downstream work quality**.
- Lasting schedule pressure also can lower work quality, since workers may attempt to achieve the target schedule by cutting corners.

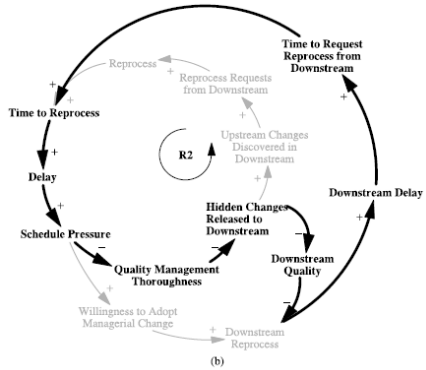


15

Quality Thinking in Construction

Dynamic analysis on project failure

- Another reinforcing loop is developed as **hidden changes not discovered** in downstream pre-checking process have bigger impact on downstream work quality, creating more reprocesses and delays.
- **'Fire-fighting' attitude** increases workloads by employing incompetent and inexperienced multi-layered workers with less familiarity with project to maintain milestones. Not adequately trained supervisors are assigned for on-site supervision of specialist works. This may cause more poorly coordinated works and potential fabrication errors to be tolerated.

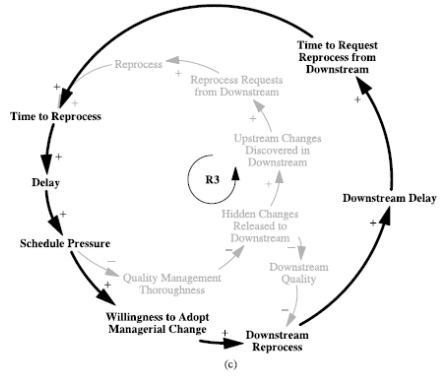


16

Quality Thinking in Construction

- As rework increases, there will be expected delay and resources per task may be adversely diverted causing more schedule pressure resulting in more quality problems in design changes and errors, as management may **try to avoid rework** on problematic tasks by modifying design and specification.
- Schedule pressure **triggers more reprocess** iterations in the downstream work, which delays the downstream work process.

Dynamic analysis on project failure



17

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CHAPTER 3

Evolving Construction Quality Beyond Traditional Practice

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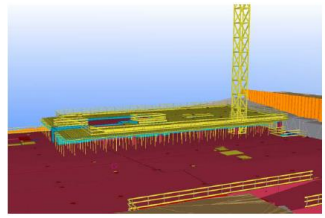
Client early design

- Understand owner expectations by defining and prioritizing the expectations.
- Synchronize and visualize design intent from early stage to allow clients in particular end users to provide inputs, and designers to understand the **intent**.
- Early involvement of stakeholders helps **evaluate alternatives** and refine the design early.



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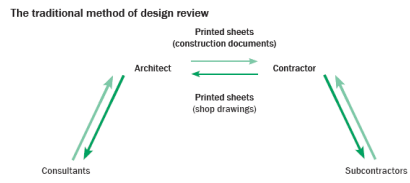
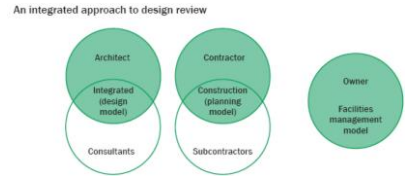
Design and detail

- Good design quality planning by **early involvement** of project stakeholders in design reviews and detection of clashes, errors and omissions identified in design.
- Exchange construction specific information early and **'freeze'** design solutions in collaborative design processes for alignment of scope.





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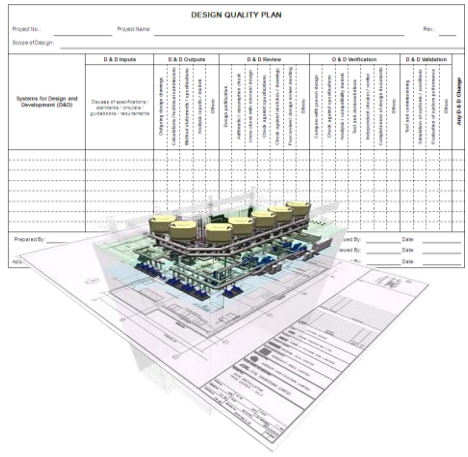
Design and detail

- BIM can provide a virtual environment, prior to building it physically, **simulate and analyze potential impacts** to prevent rework, design error, conflicting dimensioning and direction.
- Design quality planning should be improved by **aligning** master project schedule and **integrating** design verification



21

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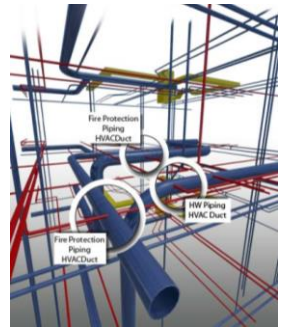
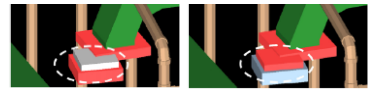
Design and detail

- BIM contributes directly to **clash detection** in 3D space in virtual design environment. Once physical or clearance clashes in various disciplines are found, designers can correct problems and iterate models until they are clash free.





22

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Collaborative planning

- Quality planning identifies the standards the project needs to comply with to achieve the required condition and satisfy the terms of the contract.
- **Preventative quality metrics** or indicators and **proactive reporting** of quality problems (or exception) and incidents (e.g. water leakage, failed test, missed activity).
- **Quality incident rate** for lesson learning and driving quality improvement.

23

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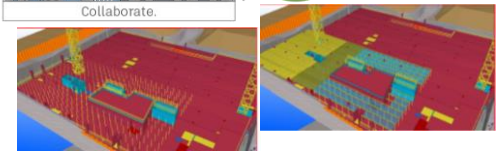
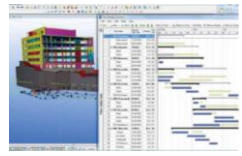
Collaborative planning

- Collaborative planning considers inputs from stakeholders and Last Planner™ commits to **reliable near-term assignments** (often weekly) in right sequence, within capacity of the crew, site condition, availability, readiness and shield production from uncertainty.
- BIM allows stakeholders to **visualise** task and also process **sequence** for collaborative planning and mutual understanding.
- A virtual '**first run study**' where users try different work methods and sequences for optimisation.





24

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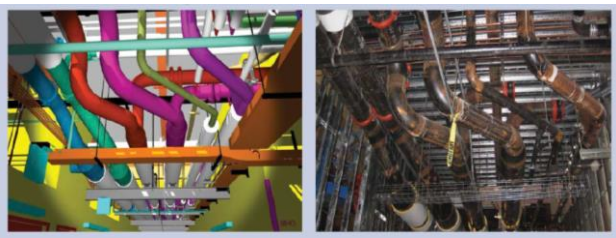
Pre-task planning

- Pre-task planning offers opportunities for preparation and planning. By virtually looking at elements to be built, it is helpful for **identifying** hazards, uncertainties and potential of error or conflict.
- Crafts are able to identify better **sequence** of activities, and materials, tools, access or space and clearance requirements before starting work. The issues can be captured during pre-task planning.



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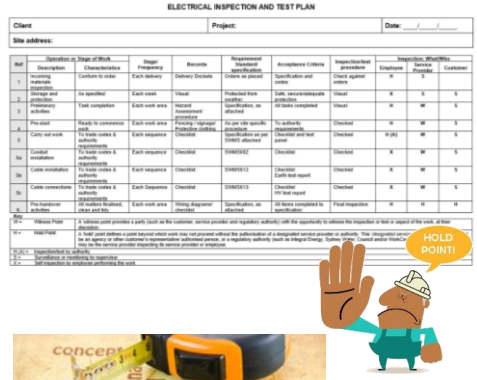
Inspection and test

- Inspection and test plan links the quality requirements by setting out critical control points at various stages within a process. The level of inspection is determined by the level of control and risk and this can be imposed as surveillance, inspection, witness or hold points.
- Planning inspection in a **proactive manner** (or during lookahead planning) is helpful for determining item to be inspected, sampling size, level of detail and responsibility.



26

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Inspection and test

- **Early capture** and rectification of fabrication errors or mistakes are always superior to passive inspection as small mistakes can 'snowball' to undesirable consequence.
- Proactive quality control identifies potential trouble spots ahead of time and put in place process to check those spots **before moving to downstream**.
- Proactive and collaborative digital inspections are valuable for involving trades and subcontractors in inspections, reporting and lesson learning.

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Documented Information

- Control of documented information for up-to-date, availability, suitability, legibility and protection.
- Version control and retention and disposition of records.
- Centralized digital document management system is helpful for maintaining most **up-to-date** set of plans and drawings. **Permission and notification settings** enable workers to receive push updates and only suitable team has access to right information at the right time.

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CHAPTER 4

Conclusion

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Conclusion

Building for the future

- Cost of poor quality in the construction industry is huge and learning from mistakes is key to improving.
- Suitable procurement types to support integration and collaboration and reasonable tender price and project schedule.
- Involvement of all levels of stakeholders at relevant stages and their contributions in early design, buildability, design quality planning, collaborative planning and pre-task planning.
- Proactive quality control in inspection, reporting and lesson learning is valuable and potential benefits from quality incident rate, proactive reporting and pay for quality in contract.