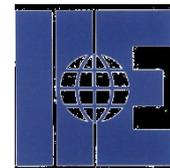


Applying Lean Thinking in Construction Project Management

Ir Dr Sammy K. M. Wan

Past President of IIE (Hong Kong Chapter)

August 27, 2015

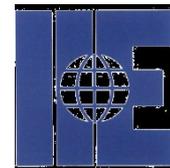


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1. Background
2. Lean Thinking in Construction Projects ?
3. Applying Lean in Project Life Cycle
3. Conclusion



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CHAPTER 1

Background



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Background

A broad concept of production

- Lean manufacturing focus on eliminating **waste** while delivering quality products on time at least cost with greater efficiency.
- Lean practices reduce wastes in all hidden forms like defect, motion, inventory, transportation, overproduction, processing and waiting. It is helpful for producing consistency and predictability in quality of work and reduction of material waste.



Background

A broad concept of production

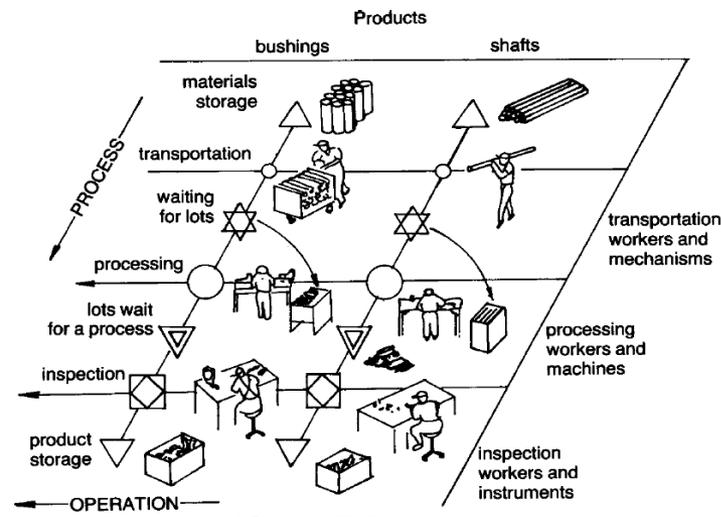
- More production wastes exist in the construction industry.
- **Cost and schedule** in the original and traditional construction paradigm but acceleration in schedules would inevitably escalate cost while reduction in cost usually extended schedules.



Background

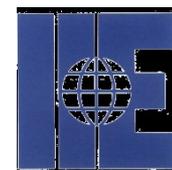
A broad concept of production

- Lean construction practices is applied to solve significant **process** issues in particular of **collaboration** between stakeholders.
- It approaches **value** rather than cost and **efficiency** rather than schedule.
- Ultimate goals in lean construction are to minimise physical and process waste, and improve value generation to client.



CHAPTER 2

Lean Thinking in Construction Projects ?



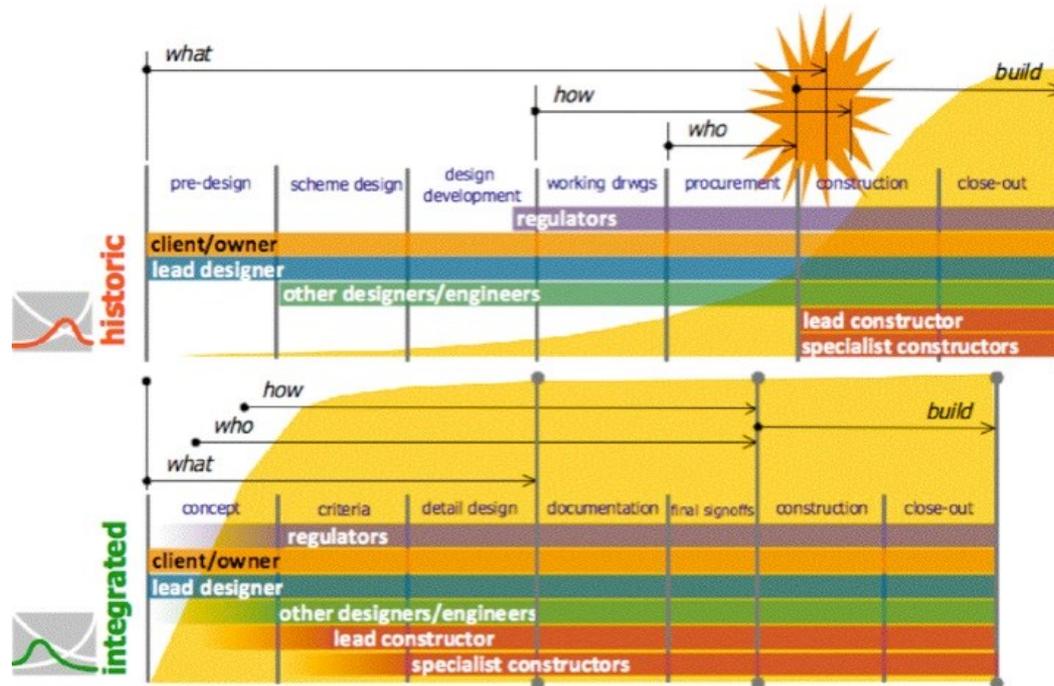
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Lean Thinking in Construction

Why conventional project fails ?

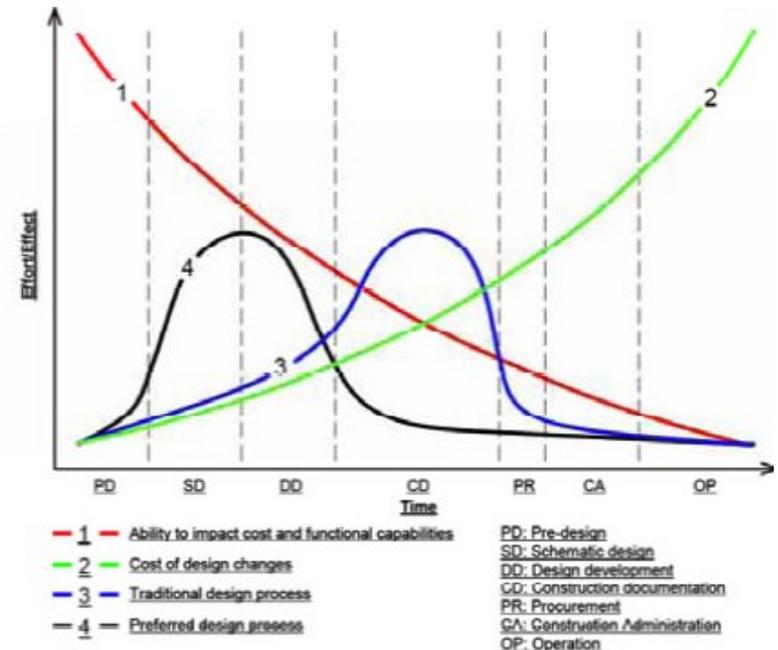
- Projects are always managed by breaking into pieces or activities by using **schedule to push** for work to begin on the earliest start date.
- Control begins with tracking and rests on **thermostat** model and action taken either to speed up or re-sequence activities.
- Reliable release of work from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



Lean Thinking in Construction

Lean production delivery

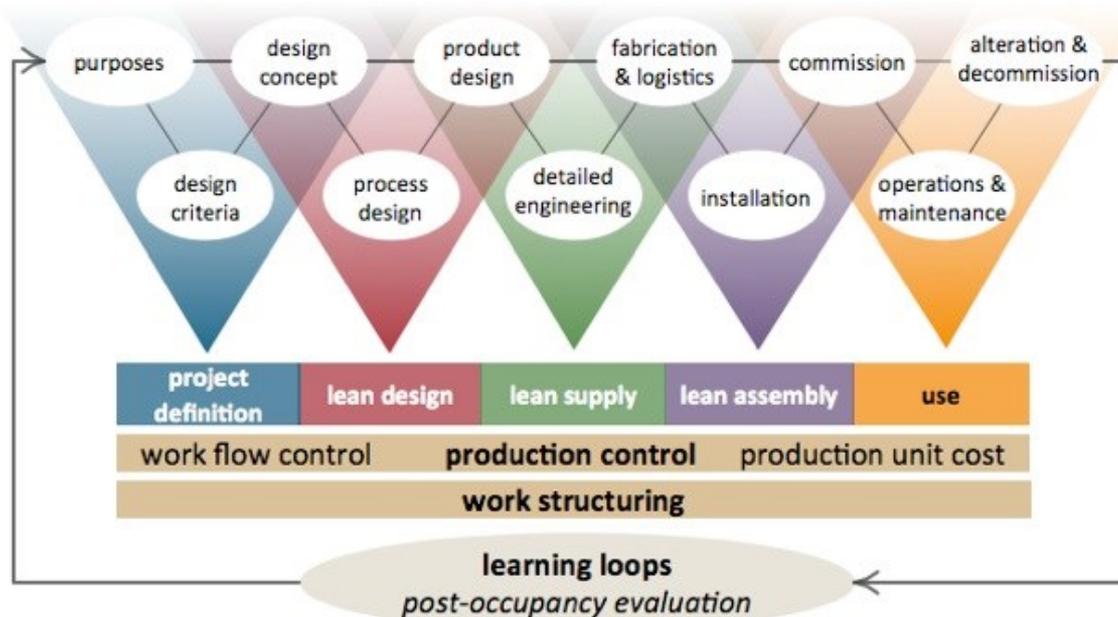
- To make significant improvements in the end-to-end design and construction process designers and constructors have to **collaborate** more closely with the client so that product design and production process can evolve together.
- The **later** that constructors are involved the more costly it is to make changes.



Lean Thinking in Construction

Lean production delivery

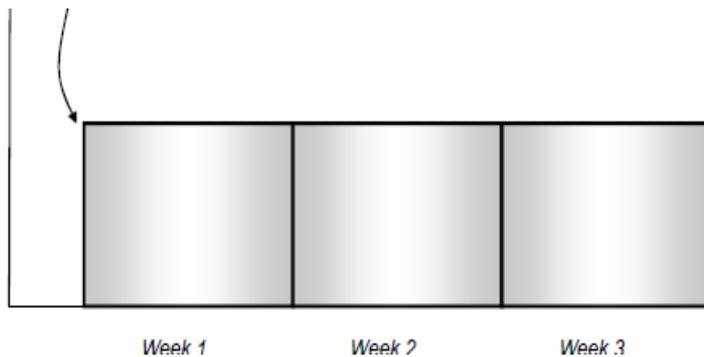
- In the industry, lean production delivery can **collaboratively** align people, systems, business processes and practices of all participants so that they can optimise value for client, reduce waste and maximise effectiveness through **all phases** of design, fabrication and construction.
- Concentration of **design** much earlier and taking lead by **client** are features of lean production delivery.



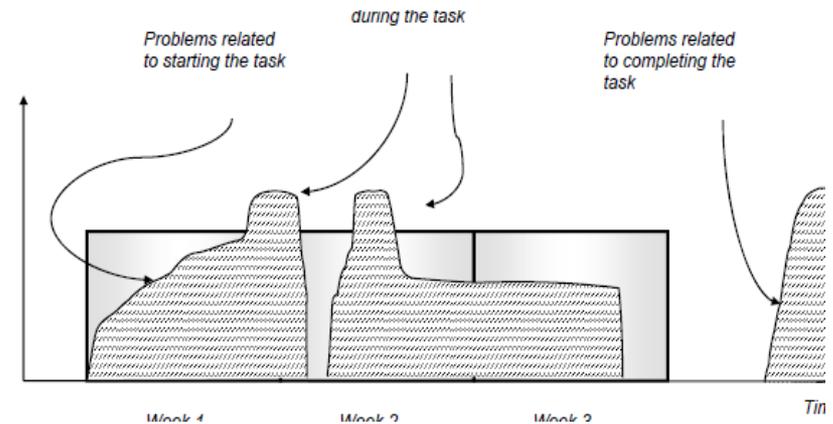
Lean Thinking in Construction

Last planner system

- 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

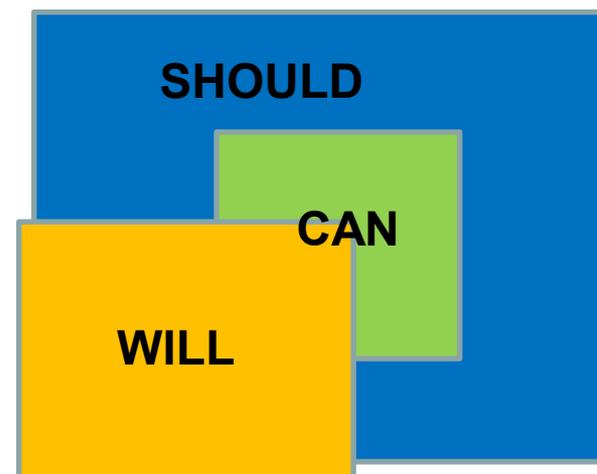
Lean Thinking in Construction

Last planner system

- Last Planner System commits to **near-term** (often weekly) tasks to make sure a reliable assignment **WILL** be done at required time after considering both what **SHOULD** from higher-level schedules and what **CAN** be done based on situation at hand.
- Assignments are likely to get done when they are well defined, resources sound, in right sequence, and within capacity of the crew. **Look-ahead plans based** upon work tasks reduce interruption, rework, or remobilisation.



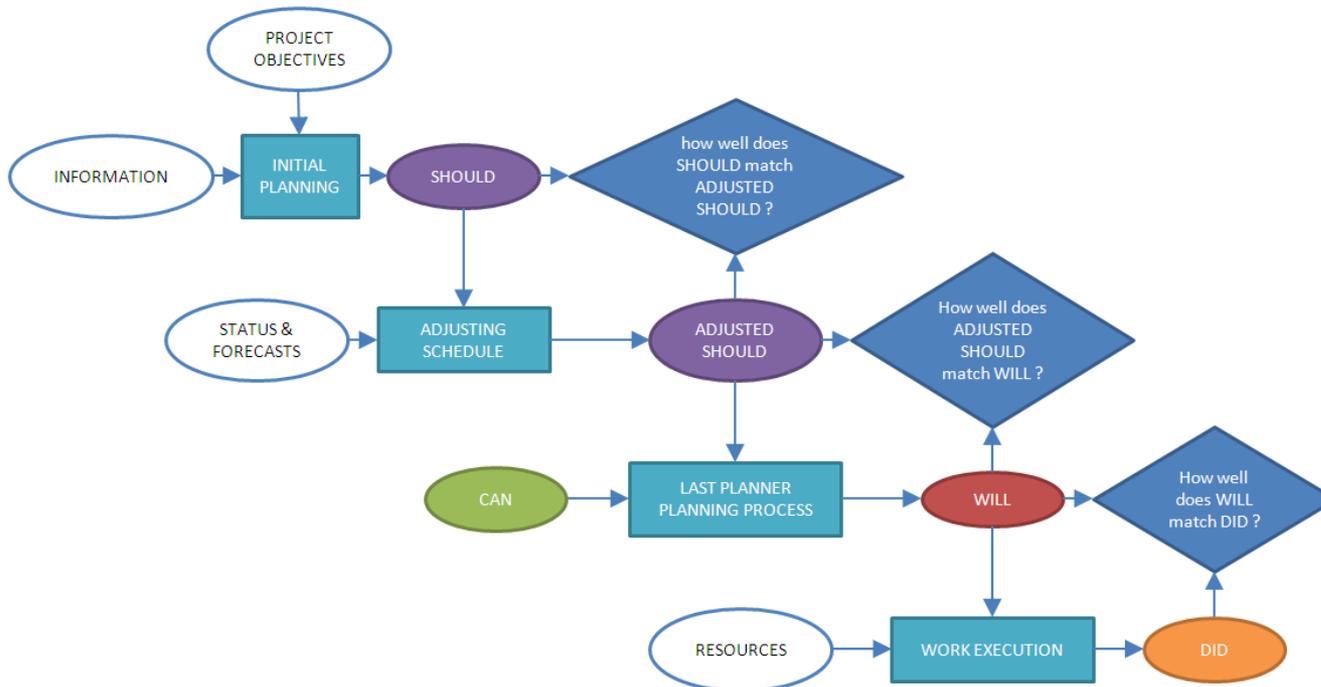
High probability of task completion



Lean Thinking in Construction

Last planner system

- Allow activities to remain in the look-ahead plan only if the planner is **confident** that it can be made ready for execution when scheduled.
- Works are planned and prioritized on weekly basis through coordination meetings and progress is measured by monitoring actual completion and **weekly learning** to improve work practices.



CHAPTER 3

Applying Lean in Project Life Cycle



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Applying Lean in Project Life Cycle

Client early design

- In project definition, it is necessary to involve all members to generate and align the needs and values, design concepts and design criteria, rather than working alone between architect and client traditionally.
- Early involvement of stakeholders helps **evaluate alternatives** and refine design early from a range of criteria set by client and design intent flow down through the various stages of the project.
- Through parametric design and collaborative processes, and value loss is minimised and late changes in design are reduced when the conceptual design or design intent is passed along to later stages.

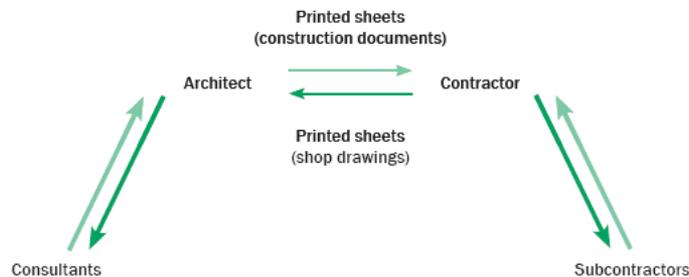


Applying Lean in Project Life Cycle

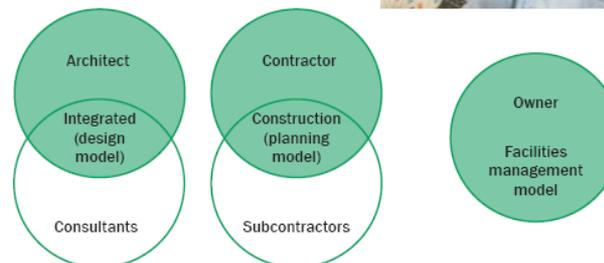
Design and detail

- It helps minimise waste by improved **design reviews** via early involvement of stakeholders. Contractors contribute by providing specific information including temporary structures and site conditions early in design process.
- Collaborative design processes help coordinate multi-discipline design by **exchanging** temporary information and **'freezing'** design solutions so that others can start design. It can minimise delays and compress overall time.
- Joint design reviews are possible during iterative modelling coordination meetings to address clashes, errors and omissions identified in the design.

The traditional method of design review



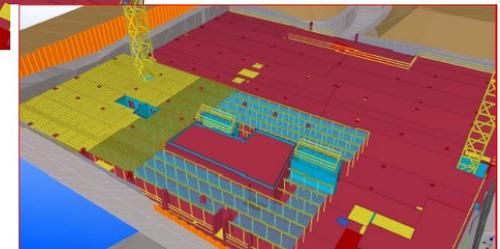
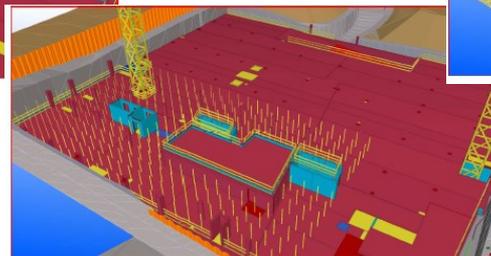
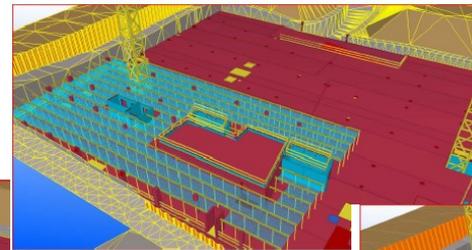
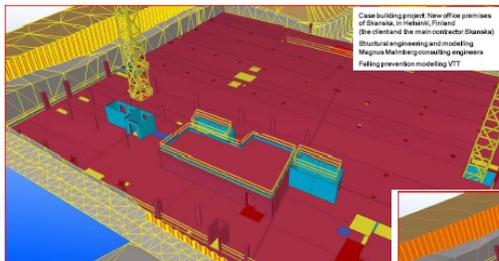
An integrated approach to design review



Applying Lean in Project Life Cycle

Collaborative planning

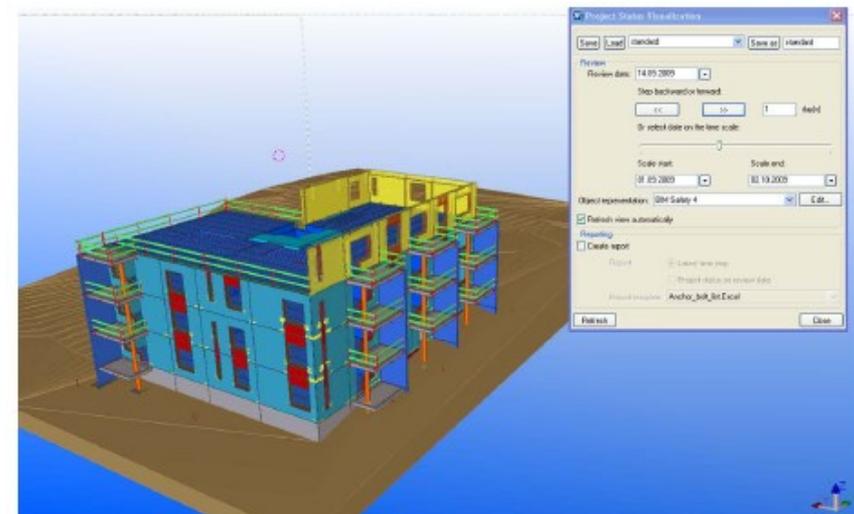
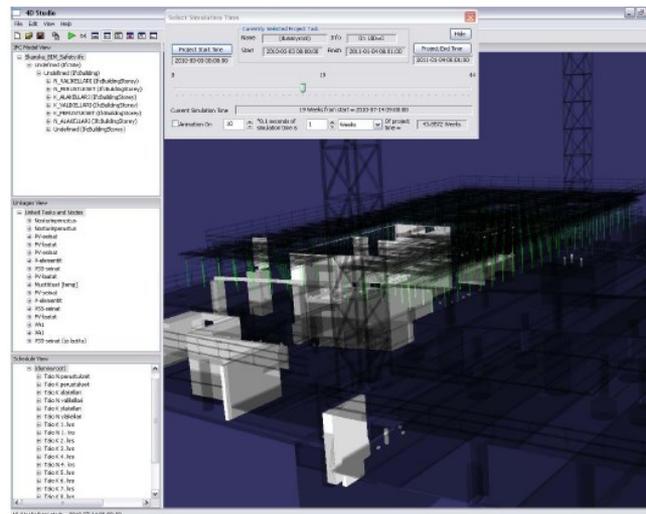
- Recently, BIM may be used for stakeholders to visualise the task and also process sequence for collaborative planning and mutual understanding, where a 3D model is linked to the project plan and simulated to demonstrate the activities for a selected period.
- 4D scheduling can also serve the function of a virtual '**first run study**' where users try different work methods and sequences for optimisation.
- Using principle in Last Planner™, it helps increase resolution of production planning and control that improves work predictability and reduces waste.



Contributions of BIM to lean goals

Simulation and analysis

- **Auxiliary information systems** or analysis models enabled by BIM contribute directly and indirectly to lean goals.
- **Value-adding calculations** and a range of parameters (e.g. structural integrity, thermal performance, acoustics, ventilation and circulation, lighting, energy, etc) are valuable for changing design process so that possibility of design improvements or fit for purpose design through rapid iteration can be realised in design practice.

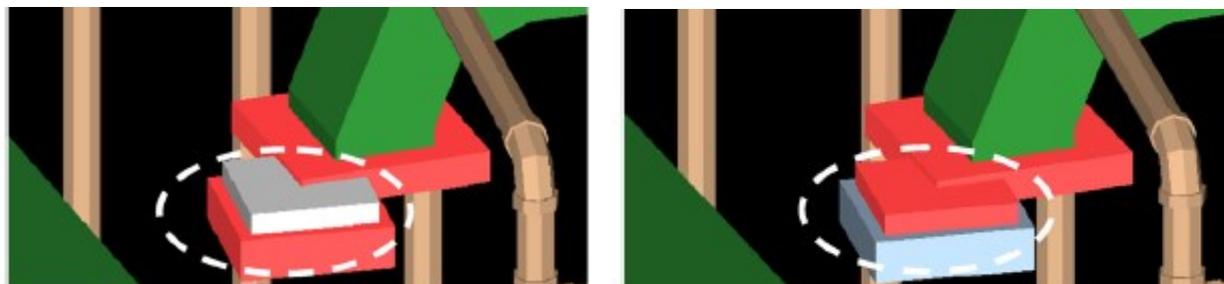




Contributions of BIM to lean goals

Clash detection

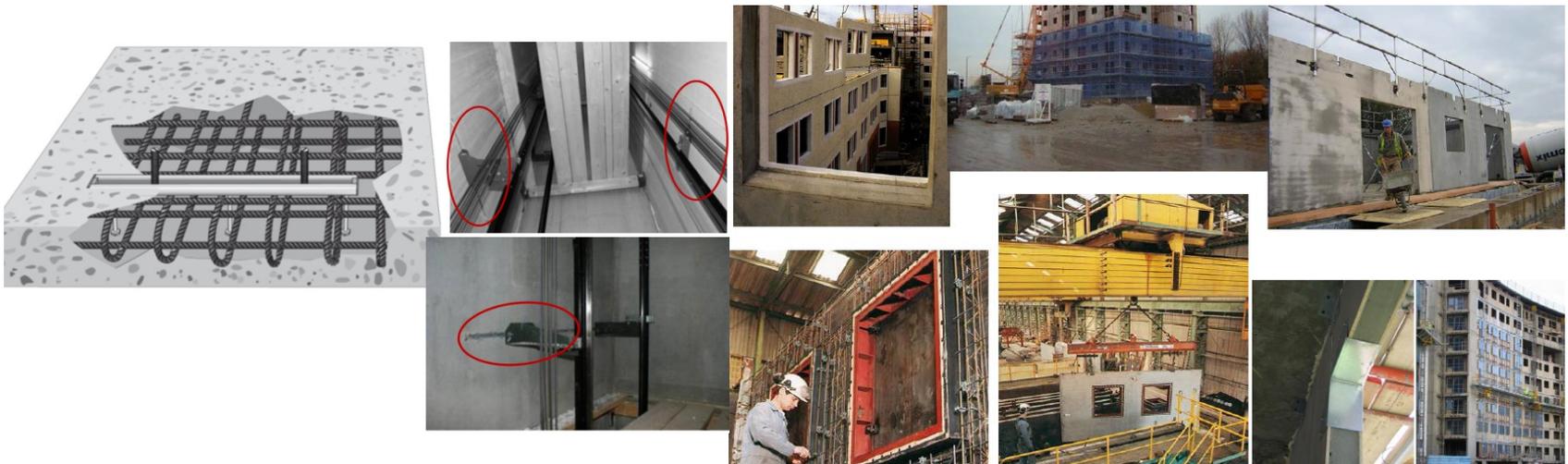
- BIM contributes directly to lean goals by clash detection. Once physical or clearance clashes in various disciplines are found designers can correct problems and iterate models until they are clash free.
- There are two types of clashes, a **hard clash** where objects occupy the same space, and a **soft/clearance clash** where objects are so close that there is insufficient space for access.
- By carrying out **automate clash checking** in a 3D space, a significant amount of time and money that would otherwise be wasted through rework or delay is saved.



Applying Lean in Project Life Cycle

Prefabrication

- The comprehensive **digital coordination** process is useful for prefabricators as it helps achieve levels of prefabrication. Fabricators are able to get large percentages of prefabrication on major components of the building systems.
- In modeling, more items are preassembled off site in a **controlled** environment compared to a construction site and trucked to the site.
- More preassembled framing panels, plumbing piping and components and cast-in channels can reduce on-site fabrications and improve work safety.



Applying Lean in Project Life Cycle

Pre-task planning

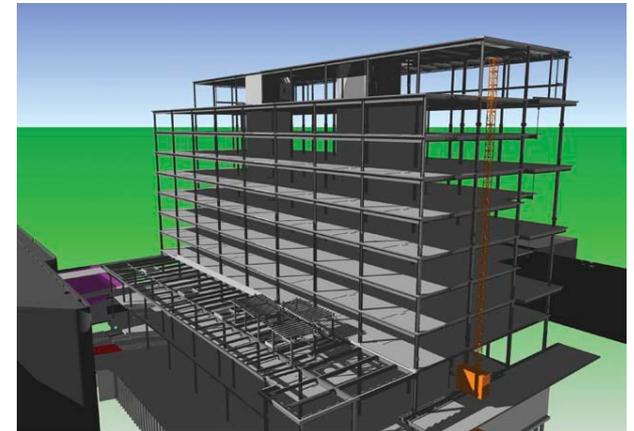
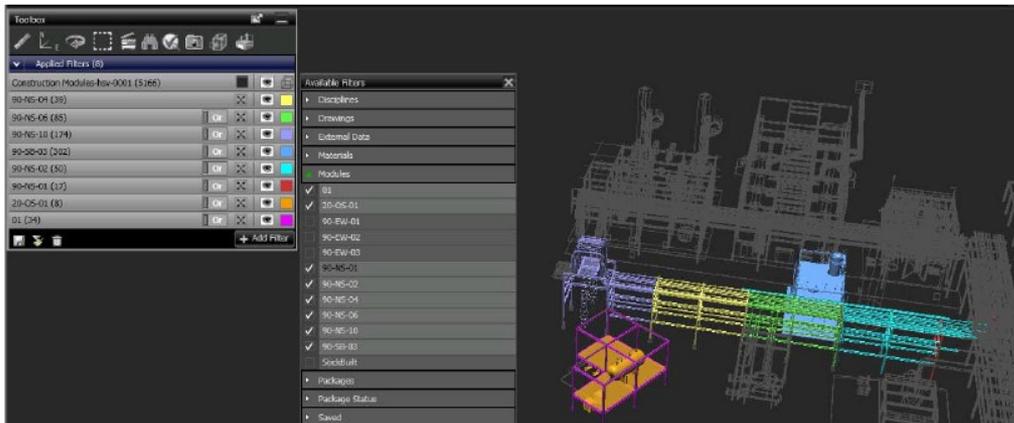
- Pre-task planning in workface planning offers opportunities for construction preparation and safety planning. In BIM, elements to be built are virtually looked at, employees were able to better **identify** the hazards and control measures so the task could be completed faster and more safely.
- Crafts were able to identify the 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.



Applying Lean in Project Life Cycle

Better-planned construction

- It allows for smoother and better-planned construction process that saves time and money and reduces uncertainty and potential for errors and conflicts.
- By using BIM, many contractors are going beyond the general uses such as clash detection, visualisation and 4D planning. Subcontractor can visually '**prototype**' all portions of their work in detail long before starting fabrication.
- **Laser scanning** for accurate as-built model to compare actual product with design (crucially in refurbishment projects). Tracking systems to locate material and components help during production management and handover processes.



Applying Lean in Project Life Cycle

Monitoring & tracking

- **Progress monitoring** allows stakeholders to focus on tasks that are behind schedule and **track** material delivery and resources flow for weekly learning.
- Through an up-to-date BIM model integrated with facilities management system and extended through **mobile technologies**, it is possible to access information and knowledge to maximise efficiency.
- Use of **RFID technology** to link physical building components with digital information is useful for on-site inspection of work and documentation, real time project progress management, and quality assurance, all of which are important aspects of implementing lean in construction.



Applying Lean in Project Life Cycle

Kanban pull production

- The use of KanBIM to support production planning and day-to-day production control on site. Visualization of process, product and method for better coordination and communication and computation of **task maturity** in weekly work planning and daily work execution.

Project Server

Planner

Smart Board Data View

Trade 4

Trade 3

Trade 2

Trade 1

Model View

Floor Plan

Section

Data View

Contractor

Work Package

Space

Resource

Control Card

Exit

Project Target WIP 58 Project Actual WIP 62 Deviation 12

Week of 30/3/2009

Contractor	Monday	Tuesday	Wednesday	Thursday	Friday	Contingency
Precast-PreCon	1 1 12	1 1 12 120	1 1 12 90	2 2 10 200	2 2 10 185	1 1 5 40
Masonry Walls-Bricks Inc.	1 1 7 65	2 1 7 75	2 1 7	2 2 15 142	1 1 7 73	1 1 4 32
Drywalls-A&B Limited	2 2 13 123	2 2 13 123	2 2 13 103	2 2 13 114	2 2 13 107	1 1 5 44
Electricity-Volt Limited	2 2 8 62	2 2 8 62	2 2 8 50	2 2 8 84	0 0 0 0	0 0 0 0
Plumbing-Aqua1	2 2 12 115	2 2 12 115	2 2 12 115	3 3 15 147	3 3 15 147	1 1 5 46
HVAC-J&B Limited	2 2 11 100	2 2 11 100	2 2 11 100	0 0 0 0	2 2 11 100	0 0 0 0

Week of 30/3/2009

Teams	Monday	Tuesday	Wednesday	Thursday	Friday	Contingency
John Smith	Main ducts - Ducts 20-31	Main ducts - Ducts 33-42	Main ducts - Ducts 33-42			
Marcus Fisher	Secondary ducts - Ducts 10a-20a	Secondary ducts - Ducts 10a-20a	End Units - Zone 1			

Tasks assigned to me

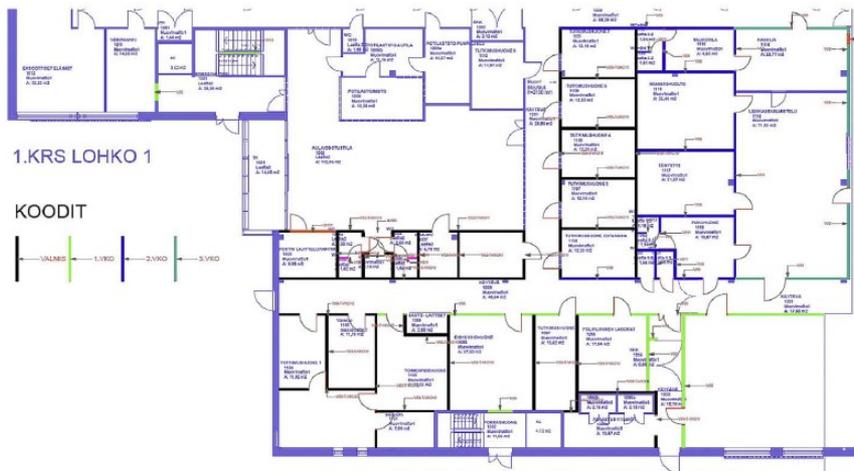
Tasks for others

KANBIM Pull Flow Control in Construction with Building

Applying Lean in Project Life Cycle

Kanban pull production

- Maturity index is displayed to planners and team leaders using color-coded symbols on tasks icons to make sure that the preconditions such as preceding work, information, materials, equipment, team, space, external conditions and safety requirements are fulfilled for task execution.
- **Reaffirm commitment** to completing mature task and report start and completion or stoppage of tasks and **timely reporting** for completion and problems.

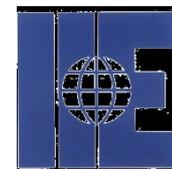


You chose to stop task:
Framing – Internal 4" partition at apartment 16-17
Please provide the reason for stopping this task

Previous work	Missing materials	Unavailable Equipment	Drills
Workspace	Faulty materials	Equipment Fault	Electric screw driver
Missing information	Safety issues	Wrong Equipment	Ladders
Design Errors	Team	Weather	Hoist
Management Instruction			
Stop	Select objects completed	Cancel	

CHAPTER 4

Conclusion



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Conclusion

Thinking for a change

- Lean thinking was proven in the Japanese automotive industry and has slowly gained traction in the construction industry, as evidenced by the increasing volume of papers.
- Incorporating scheduling and lean tools can achieve a look ahead schedule and a pull technique through a proper schedule. Consequently, converting the flow of resources from interrupted to uninterrupted with idle and waiting time consequently reduced.



Conclusion

Thinking for a change

- Lean construction and BIM are not only synergistic but that the synergy spans the entire life cycle of the project through rapid evaluation of alternatives, set based design, joint design reviews, collaborative planning, clash detection, simulation and analysis, etc.
- Some emerging initiatives are available for involving mobile solutions, GPS devices and RFID for smoothening work processes and maximising efficiency.
- Lean is about thinking smart.

