

BUILDER INSIGHT



Bulletin No 2 | 330 Goldstream Avenue

Lean Construction Practices: Wood Social Housing Project

Located in the City of Colwood in the Capital region of Vancouver Island, 330 Goldstream Avenue comprises 102-units of nonmarket housing for individuals, couples, and families with low-to-moderate income.

Developed by the Greater Victoria Housing Society (GVHS) and funded by BC Housing, the six-storey wood frame building comprises 6,121m² (65,862ft²) of gross floor area over two storeys of underground parking.

The building accommodates a range of unit sizes – 50 studios, 39 one bedroom, one two bedrooms and 12 three bedrooms.

Tight Budget and Timeline

GVHS had a tight budget and timeline. Kinetic Construction offered to use Lean Project Delivery to help manage the project, streamlining the construction phase to address these constraints.



Right: Lean Preparation Workshop.
(Source: Scius)

Left: Last Planner in the site Big Room.
(Source: Scius)



This bulletin series covers different aspects of this innovative social housing project. Find them all in the BC Housing Research Centre Library.



FACTS AND FIGURES

Construction timeline:
January 2019 – May 2021

Construction budget:
\$18.99m

Residential units:
102

Site area:
3,820m² (41,103 ft²)

Total Gross Floor Area:
8,323m² (89,555 ft²) inc. Parking

Gross Floor Area, Residential:
6,121m² (65,862ft²)

Building Height:
23.9m (78.4ft)

Occupancy Classification:
BCBC 2012, Group C- Residential
(6 levels), Group F3 – Garage (2 levels)

PROJECT TEAM

Owner:
Greater Victoria Housing Society

Architect:
Cascadia Architects

Envelope and Energy modelling:
RDH Building Science

Structural Engineering:
RJC Engineers

Building Code and fire science:
GHL Consultants Ltd.

General Contractor:
Kinetic Construction

Timber and prefab. installer:
Ron Anderson & Sons

Timber panel fabricator:
ZyTech

Siding contractor:
Brytar Contracting

Research management:
Scius Advisory

Lean coach:
Shift2Lean

Video, webcam and photography:
Multivista

Lean Project Delivery

Kinetic was the Lean Project Delivery champion. Lean Project Delivery (or simply Lean) improves project delivery by eliminating inefficiencies and “waste”. Lean is not about reductive planning or special practices: it focuses on the project team members’ expertise and effort to delivery exactly what is needed – when it is needed.

330 Goldstream’s owner and operator Greater Victoria Housing Society (GVHS) brought Kinetic on to the project in the late design stage for construction review. Although achieving BC Energy Step Code 4 was not contemplated in the project budget of \$18.99m (\$2,905/m² – \$270/ft²), based on a limited pre-construction consultation, Kinetic assessed that it could be done while maintaining the schedule by using Lean.

Lean Project Delivery: An Efficient Building, Built Efficiently

Lean is a highly collaborative process that involves the application of goal-based “pull planning”. Essentially, Lean starts with the owner’s project goals, or what the owner “values” most, and walks backwards from this point to plan the design and construction of the building project. Kinetic had successfully utilized Lean on several projects prior to 330 Goldstream.

Target Value Design

Target Value Design is the integrated design and construction practice that the project team deploys to ensure their efforts end up delivering a building that satisfies the owner’s goals, within the constraints of the project. Project constraints can include (but not be limited to) budget, schedule, and other factors such as occupant comfort, energy efficiency and long-term service costs.

Target Value Design starts with the Owner’s Project Requirements (OPRs). From the OPRs, the team collectively establishes the Conditions of Satisfaction (CoS) which sets what successfully achieving the OPRs looks like according to both the owner and project team.

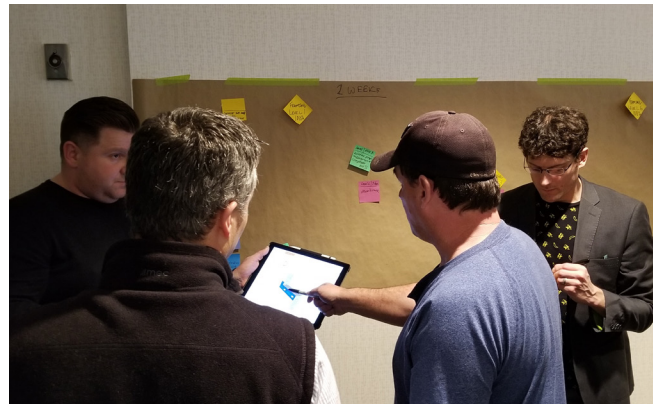
Continuous Estimating

Continuous Estimating allows the owner to quantify “value” dynamically at any given time, by regularly assessing the feasibility of the OPRs and CoS. Continuous Estimating occurs at the same time as Target Value Design (ideally starting during pre-design) so the owner, design and construction team can determine “in real time” whether the value generated is worth the cost, time and resources required to deliver it.

Full Team On-boarding

To effectively participate in Lean pull-planning, Target Value Design and Continuous Estimating require the early engagement of the design and construction teams.

In particular, the contractor, key trades and suppliers all need to provide active input about costs, effort, time and resources during the design process. This detailed information is required for the owner to make informed decisions about the value of their OPRs and CoS, ensuring design the owner approves can be built efficiently during construction.



The architect, general contractor, subtrade and window supplier discussing envelope details and construction sequence. (Source: Scius)

Lean Construction Institute

Lean Project Delivery is widely used by the construction industry across the globe. Kinetic Construction derives their definitions and practices from the US-based Lean Construction Institute: leanconstruction.org.

LEAN ACRONYMS

Lean – Lean Project Delivery: also commonly known as “Lean” in short form.

OPR – Owner’s Project Requirements: Owner’s priority goals for the project, such as occupant comfort, energy performance or target budget.

CoS – Conditions of Satisfaction: Conditions for satisfying OPRs.

TVD – Target Value Design: Designing to meet CoS/OPRs – and nothing extra.

CE – Continuous Estimating of TVD iterations to assess cost-benefit and impact.

LEAN GLOSSARY OF TERMS

Value – Defined as what the owner prioritizes as OPRs; qualified/quantified as CoS. Not always cost related.

Production Sequence – Sequence of tasks require to construct a building. Broken down by phase milestones.

Buffer – Stockpiling time, resources and equipment in case.

Last Planner® – The person closest to the work with authority to make decisions regarding schedule, team and resource allocations, and make reliable commitments to the project team.

Make-work ready – Last Planners plan the production sequence of tasks’ prerequisites and dependencies are ready, allowing for non-stop progress.

Big Room – Common meeting room for the project team, equipped to facilitate collaboration and planning.

What is “waste”?

In the world of Lean, waste is defined as “non-value generating activities that are unnecessary to achieve CoS/OPRs, or which negatively affects people, project and/or product (building).” Globally, the hidden cost of waste in construction is estimated to be over \$1 trillion a year.

Lean eliminates waste through inclusive, total project planning. Utilizing “Last Planner”, Lean teams plan backwards, setting only tasks needed to deliver the owner’s building requirements. The different types of “waste” can be summarized by the ‘DOWNTIME’ acronym.

DOWNTIME

Sources for waste are classified by “DOWNTIME”

Defects	Re-work or changes
Over-production	Extra material and labour
Waiting	Idle or wasted time
Not utilizing talent	Wasting expertise
Transportation	Time and cost of delivery
Inventory Excess	Hoarding or damage risks
Motion Waste	Greater effort to achieve same result
Excess processing	Over design or excess effort

TIMMESS

To address sources of waste, make-work ready planning utilizes TIMMESS:

Tools	Do have all the tools I need?
Information	Do I have the right information? Have I talked to the right people?
Material	Do I have all materials? Is the substrate ready?
Manpower	Do I have everyone I need? Including other trades?
Equipment	Do I have the equipment required to complete my task?
Safety	Do I have all my safety equipment? Do I know all the hazards on-site?
Space	Do I have room to work unimpeded? Who do I need to coordinate with?

Last Planner® is a trademarked system of the Lean Construction Institute. For more detailed information as well as a free guide: leanconstruction.org/lean-topics/last-planner-system.

Lean Project Delivery: “The Toyota Way”

Lean is the concept of efficient manufacturing and operations that grew out of the Toyota Production System in the middle of the 20th century. Toyota developed Lean to institutionalize continuous improvement and respect for people into their operations. Their goal was to deliver a car that matched exactly what was needed by customers – no more, no less - with as little waste as possible. Lean has four principles:

- Long-term (over short-term gain) philosophy
- The right process will produce the right results
- Add value to the organization by developing your people
- Continuously solving root problems, driving organizational learning

Lean for construction in Canada

Starting in the 1990’s, the principles of Lean manufacturing have been making their way into construction projects. With some modifications, Lean is being used where similarities with manufacturing exist. For example, in prefabrication.

At its core, Lean is a team process that ensures each team member’s strengths and talent are respected and leveraged to maximize value for the owner. Kinetic was keen to point out that Lean is not a panacea for systemic industry wide efficiency challenges. Rather, it offers a pathway to improve productivity, performance, team satisfaction and project outcomes by focusing on allowing individuals within a team to use their expertise to successfully build increasingly complex and integrated buildings. What Lean does demand from teams is an open mind and a commitment to the effort necessary for planning ahead.

Kinetic construction adaption: Lean project delivery

Team On-boarding	Master Planning	Phase Planning	Day-to-Day-Lean
<p>Start: Design Phase</p> <p>Form Executive Team:</p> <ul style="list-style-type: none"> • Owner • Prime Consultant • General Contractor • Other key stakeholders <p>Set Expectations:</p> <ul style="list-style-type: none"> • OPRs • CoS • Lean requirements 	<p>Design Phase</p> <p>Design-Construction:</p> <ul style="list-style-type: none"> • Target Value Design • Continuous Estimating <p>Construction Planning:</p> <ul style="list-style-type: none"> • Production Sequence • Milestones • Key tasks 	<p>Late Design / Construction Phase</p> <p>Task Sequencing:</p> <ul style="list-style-type: none"> • Schedule and sequence tasks • Identify key hand-offs • Identify resources 	<p>Construction Phase</p> <p>Make-work Ready:</p> <ul style="list-style-type: none"> • Coordination in the Big Room • TIMMESS checklist • Execute tasks <p>Continuous Improvement:</p> <ul style="list-style-type: none"> • Debrief: What could have been better?

330 Goldstream project: modified Lean project delivery

Workshop #1	Workshop #2	Big Room: Phase Plan	Big Room: Weekly Lean Planning
<p>Late Design Phase</p> <ul style="list-style-type: none"> • Limited to Executive Team • Limited Design–Construction review 	<p>Start of Construction Phase</p> <ul style="list-style-type: none"> • Project Lean on-boarding • 1-Day Construction Planning 	<p>Construction Phase</p> <p>Task Sequencing</p>	<p>Construction Phase</p> <p>Make-work Ready:</p> <ul style="list-style-type: none"> • Weekly sessions • Limited Consultant Participation <p>Continuous Improvement:</p> <ul style="list-style-type: none"> • Limited to Construction Team

Lean Planning is Efficient Productivity

The focus of Lean planning is on value generating activities. Lean defines productivity as doing only what is needed to achieve the desired outcome. On typical projects, contingencies are built into project team members' scopes of work to compensate for unexpected challenges and non-value generating activities, defined as waste by Lean. Waste is summarized by the acronym DOWNTIME, and include money, time and materials arising from things like delays, waiting, changes, errors, etc.

Generally, waste is exponential. Individuals within a project team protect themselves against other team members' potential waste through time, effort, or resource buffers. Everyone's contingencies scale based on the number of variables, their upstream and downstream dependencies, and the risk they are exposed to. Unfortunately, in Canada, these non-value generating contingencies are often needed because of the siloed nature of design and construction, the way risk is passed down the supply chain, and traditional methods of procurement and project delivery.

How Last Planner minimizes waste and buffers

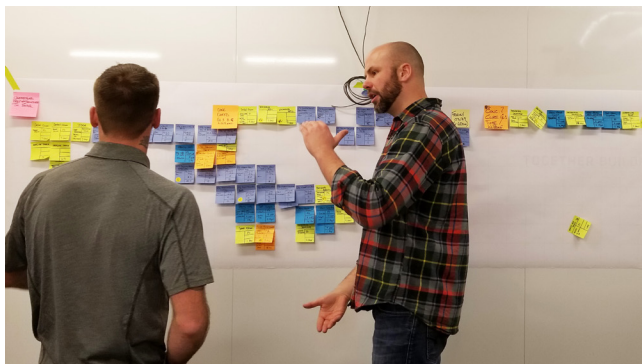
Last Planner "walks backwards from the final task" so that the team only plans and executes the sequence of tasks that contribute to the value generating activities that lead to satisfying the owner's project requirements.

Last Planner uses the acronym TIMMESS to identify what the design and construction teams need to accomplish their tasks. The TIMMESS checklist articulates the

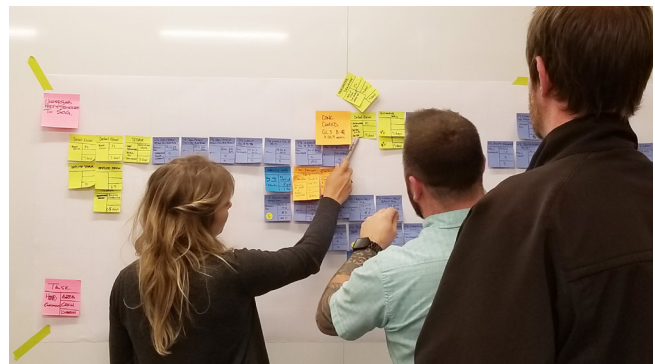
practical requirements and identifies the team members responsible. This helps everyone to work together and fulfil their responsibilities on time. The project team can then efficiently progress through the sequence of tasks with the least effort, thereby maximizing productivity. Thus, Last Planner ensures that only what is needed to be done gets done at the right time, thereby minimizing waste.

330 Goldstream Lean Planning timeline

May 2018	Kinetic Construction hired for construction consultation Lean Planning Workshop #1 Lean Boot Camp
November 2018	Contract Award: Kinetic Construction
January 2019	Construction starts Lean Planning Workshop #2 Lean On-boarding
February 2019	Big Room is setup on-site at 330 Goldstream Ave
March 2019	Last Planner begins with excavation/ site services phase planning
March 2019 – February 2020	Last Planner day-to-day: trade team meet weekly to plan and collaborate on tasks 2-6 weeks in advance
March 2020	COVID-19 halts Last Planner



Phase planning, excavation and site work. (Source: Scius)



Last planner for each task in the production sequence work together to ensure efficient "production". (Source: Scius)

Lean Workshop #1 Lean Boot Camp

In May 2018, BC Housing hired Lean coach Shift2Lean to prepare the owner and consultants on 330 Goldstream for their first Lean project. Shift2Lean put on a one-day Lean Project Delivery “boot camp” to introduce the team to the basics of Lean, and to assist them setting 330 Goldstream’s OPRs and CoS.

At the time of the workshop, Kinetic Construction, who originally proposed the adoption of Lean, was already assisting the design team with construction consultation. In Kinetic’s experience, the workshop occurred later than was optimal to process the full benefits of Lean. However, the Last Planner still had the potential to positively affect the construction phase of the project.

Lean Workshop #2 Lean On-boarding

Once the construction contract had been awarded to Kinetic, the executive team (the owner, the architect and the contractor) organized a two-day workshop to on-board the trade companies. The workshop was held January 9-10, 2019. Documentation of the workshop (video, photos and note taking) was funded by BC Housing.

On the morning of day one, Shift2Lean delivered a Lean Boot Camp to over thirty trade contractors and suppliers. In the afternoon, the workshop participants completed a series of hands-on exercises that demonstrated the practical application of Lean to help them see how Lean can add value to the project.

On day two, the executive team introduced themselves and presented the OPRs and CoS, including the budget

and schedule goals. They also went over the team rules of engagement. Open communication and collaboration being critical, the rules of engagement broke down some of the traditional communication silos.

Initiate Last Planner

Workshop #2: master planning

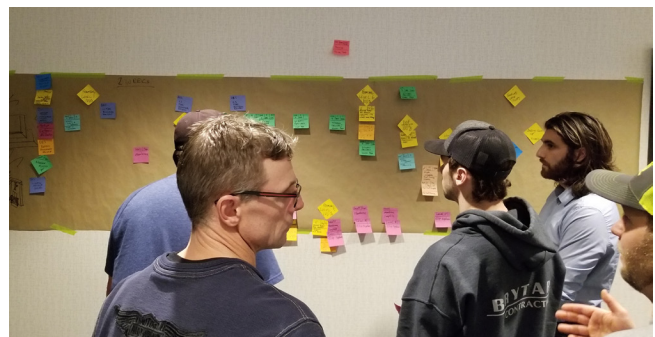
Throughout the Last Planner “backwards” planning process, Kinetic used sticky notes to visualize, collaboratively plan and track changes as the project progressed.

During this workshop, the entire project team began to use the “Last Planner” process, designating key activities and targets, and mapping out the project production sequences. A long sheet of paper was attached to the conference room wall, and team members posted sticky notes that indicated the project’s key milestones. This included excavation and foundations, site services, framing and structure, roof, building services, elevator, suite fit out, as well as key inspections, airtightness testing and field reviews.

The owner, contractor, trades, and consultants all had the opportunity to see the complete project timeline and discuss the mapped sequence. This allowed the team to begin in-depth conversations of the project DOWNTIME and TIMMESS requirements. The exercise “broke the ice” between trades, consultants and suppliers that would normally not have direct contact. It also built goodwill and established a culture of collaboration that would become important as construction progressed.



Day #1, Lean exercises. (Source: Scius)



Day #2, setting up the project Lean logistics. (Source: Scius)

Big Room: Phase Planning

The first Phase Plan was completed in January 2019. Phase Plans are typically based on key project milestones and are formed within the Master Plan. For example, Kinetic used the Site Work Phase Plan to guide the relevant trade team through excavation, site work and foundations as a production sequence to the start of the Framing Phase Plan – the next major milestone.

Big Room: Day-to-Day Lean Operation

Last Planner is a dynamic planning process that identifies which tasks from the Phase Plan need to be scheduled and “made-ready” to start. All trades and suppliers (and ideally, relevant consultants) with upcoming tasks meet in the Big Room on a weekly basis for “make-ready planning” which typically looks ahead in two to six week rolling cycles. Collectively, they set up and “check-off” the critical make-ready items summarized by TIMMESS.

Kinetic used TIMMESS to represent the key items a trade, supplier or consultants need to have ready to perform their task. Make-ready planning in rolling cycles ensures that readiness is established well before a task is scheduled and that the production sequence can progress smoothly. It also allows the team to organize and plan together for efficiencies and mutual benefit, such as sharing lifts, preventing obstructions, or organizing material and equipment storage. This was particularly important for the 330 Goldstream site which faced significant access constraints. Once tasks are made-ready, they are “banked”. Kinetic can then confidently plan work schedules from this bank. Thus, the Last Planner eliminated the potential for wasted time and cost to the project by reducing the risk of misunderstanding, duplication of effort and unforeseen disruption.

Once the tasks had been completed, the team reviewed the lessons learned in post-scope-of-work meetings. Often, these discussions had an important bearing on 330 Goldstream’s next Phase Plan and milestones.

Lean Link to Prefabricated Wood Construction

The project team opted for a prefabricated assembly to address the multiple and compounding challenges of energy efficiency (requiring a very air-tight building envelope), tight budget and schedule, and constrained site access with limited area for material storage. Prefabricating the light-wood structure delivered the following benefits:

1. Shop drawings and off-site fabrication of the panels could proceed at the same time as site work and foundation forming, reducing lead times.
2. “Just in time” delivery of panels and floor framing could accelerate building erection while minimizing the space needed for site storage of materials.
3. Enhanced quality control of the envelope assembly and airtightness by pre-applying the sheathing membrane.
4. Reduced risk of weather exposure via an expedited construction sequence meant that the building could be enclosed and protected sooner.

Lean is key to unlocking the advantages of prefabrication which derive from manufacturing replicable elements in covered facilities thereby maximizing safety and quality, and then being rapidly erected on-site to minimize exposure to weather. However, the Last Planner needs to be initiated early enough for the building design to be optimized for prefabrication (i.e., simple, standardized layouts and connections, that are easy to transport, lift and install).

At a minimum, Lean requires the contractor, fabricator, and panel installer to participate in the Last Planner process with the design team. Last Planner specifically refers to the person on the team who is closest to the work, and who has planning and resourcing authority. For prefabrication, Last Planner’s “walk back” approach ensures that those who will fabricate, deliver, and build the building can assess the OPRs and CoS, and incorporated their input and requirements into the design. This ensure what is designed can be practically and efficiently built later.

Project Challenges

Late Adoption of Lean

The late introduction of Lean to the 330 Goldstream project meant Target Value Design and Continuous Estimating were not utilized. Without backwards planning during design, the construction team was translating the design into buildable solutions while the building was being built, much like a traditional project.

The hard delineation between the design and construction meant the contractor, consultants, trades, and suppliers put in a lot of extra effort during the time and resource intensive construction phase to resolve construction details. Despite these limitations, the team was able to work through these challenges successfully.

Project Team Participation

The adoption of Lean was not reflected in the owner's time or consultants' fees. The owner and consultant team's participation are a critical component to Lean's decision-making process that underpins the goal of eliminating waste before it can occur, by planning ahead during the design phase. This meant Kinetic and several key trades spent extra time and effort during the time-intensive construction phase, when short-notice changes have greater effect on cost, time and demand greater resources (waste).

The lack of decision-making authority of some of the

trade representatives attending the weekly Last Planner sessions also affected the team's ability to make decisive decisions and act quickly (see next item).

Decision Workflow

The size of the project team made it difficult to coordinate all the various decision workflows. For example, team members nearest to the work onsite (notably trades) often needed decisions to be made quickly, while others such as consultants and owner-side representatives, had different priorities that did not always consider the time-sensitivity or coordination impacts of their decisions on the project construction schedule. Last Planner (ideally) requires all those team members who have a role in a key decision to address them ahead of time during planning before they become critical and impact affecting those building the building.

COVID-19 Impact

Health and safety restrictions imposed during the COVID-19 pandemic effectively ended Last Planner in the Big Room when social distancing regulations prevented indoor group meetings. The team tried several strategies, such as meeting outdoors or online, but Last Planner relies on regular, close, in-person collaboration. Reviewing drawings, viewing the project plan and sketching out details are key to decisively addressing issues during planning. Despite its popularity with the trade team, Last Planner was halted in April 2020.

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