

Construction Agility

An Integrated Management System

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Background and Introduction

Executive Summary

Construction Agility is a management system to be utilized by project managers to create a visual representation of work in progress on the jobsite. This visual component of Construction Agility increases awareness of job site activities among the general contractor, subcontractors, and visitors, thus increasing safety. The system is a Kanban, otherwise known as a batch system, that displays critical activities with physical moveable cards that display the task, the duration, and the proceeding party. There is a focus on handoffs which requires a willingness to open communication. The visual appeal and simplicity of the batch system for all to view promotes accountability among participating parties. This also doubles as a check and balance for completed tasks, increasing quality. The backbone of this system is not alone the visuals, but the collaborative and communicative team culture that is fostered around it. This team environment and learning culture is a facilitated through periodic reflection and input from all participants. With the proper application, Construction Agility should decrease waste and increase productivity, safety, turnover rates, and communication.

Introduction to Agile Management and Lean

“Agile management, agile process management, or simply agile, refers to an iterative, incremental method of managing the design and build activities of engineering, information technology and other business areas that aim to provide new product or service development in a highly flexible and interactive manner.” If you have noticed, construction is not included in the definition’s description. “Lean manufacturing or lean production, often simply "lean", is a systematic method for waste minimization ("Muda") within a manufacturing system without sacrificing productivity. Lean also takes into account waste created through overburden ("Muri") and waste created through unevenness in workloads ("Mura").”

Breakdown of Construction Agility

Agile uses a Kanban system for visual representation. At the beginning of the project the team goes over deliverables and categorizes them by which team member is responsible, the task duration, and the task prioritization. The Kanban system is broken up into six batches or columns: Backlog, Responsible Party, Weekly To-Do, In-Progress, Review, Complete. Each team member has a backlog which is used as storage for future activities. Each week activities are moved from the Backlog batch and placed in the To-Do batch, acting as a more pertinent backlog. Activities are initiated when the activity card is moved to the In-Progress batch. Once an activity is complete it is moved into the Review batch. Each member has the opportunity to review if desired, but the final move to the complete batch will be decided by the designated champion of that phase. Periodically throughout the process the team stops work and meets

briefly for progress reports which discuss three main points: “This is what I have done”, “This is what is preventing me from completion”, and “This is what I plan to-do next”. Monthly, Weekly, or daily as decided by the team; there is reflection on the process to facilitate a learning culture and growth of team members for future tasks and projects.

Preliminary Research

An Opportunity to Eliminate Waste

Program Management 2.0., Thomsen, C. and Sanders, S.

The construction industry has approximately 57% waste. In comparison, the manufacturing industry has approximately 12% waste. (Thomsen and Sanders, 2011.) There is an opportunity here to eliminate waste and make construction companies more lucrative. I looked to develop a management tool, Construction Agility, to help eliminate this waste.

Success factors for Agile Management

Agile project management in the construction industry - An inquiry of the opportunities in construction projects, Mattias Yllen

The first point I want to discuss from Mattias Yllen’s thesis is the communication aspect of Agile. In Agile, communication is not just delivered but also received. Agile limits the amount of information a person, or receiver, needs to pay close attention to. This requires close attention of the receiver when they are receiving certain information. Due to this, the information being received needs to be explicit and to the point. The information is not holistic of the project, but like previously stated, limited. If desired, the receivers can pay attention to all information being delivered to the team, though it is not necessarily expected of them. In order for this communication to be effective, dialog needs to work on both end. Employees need to be involved in decisions, able to give input, and empowered.

Transitioning into the next point, good communication comes from planning. “To miss manage the meetings is to mismanage the business.” (Yllen, 2012, p. 15) Agile needs to build into the company’s strategy. Meetings are built into Agile. These meetings need to show measurable results with a clear purpose and goal of each. This again goes back to communication where the meetings need to engage and maintain focus of each participant. Mattias recommends meetings need to be held standing not sitting. He also recommends that meetings be held before lunch or end of the day coming from the notion that hunger drives efficiency in terms of meeting time and structure.

A problem Mattias found was that the aim for both Lean and Agile is smaller deliveries that are developed throughout the project, not the beginning. This can be a contractual issue and can be deferred to whomever the project's client is. For agile to be successful, the client must be trusting of the contractor and open to the non-pre-defined incremental deliveries. Many clients like to know what their money is going towards, and they do in a holistic sense, but not in a parceled step by step procedure with Agile.

Coming off this aspect of a divided process into smaller parts, there is opportunity for increased involvement for the client. The client has an opportunity to review each presentation which allows for opportunity to discuss and decide future course of action. This increased client involvement does rely on the occurrence of these meeting though, which should be held at a maximum of a month's interval.

When practicing Agile, the project team needs to determine which tasks are most important and least important and organize accordingly. It is good to involve the client in these meetings because the client can determine and work with the team on determining what is most important. The client can now assist in the direction of the project and the qualities they see most important.

There is a self-governance aspect of Agile meaning that even though the captain of the team has the overall responsibility, every single position in the team has his or her own specific responsibilities and authorities. Everybody on the project team still has the same goal to complete the project on schedule, within budget, and with the highest quality, though collectively divided. There is a collective responsibility among that team that even though each member has specific responsibilities, everyone is responsible for assisting each other.

Agile is unique in that it has a Scrum master. The scrum master does not decide what the team does, but instead supports the team and helps keep the team working together and efficiently. In a sense, the Scrum master acts as a guide for the team to help in decision making. On the contrary, the Scrum master does decide the duration of review huddles, establishes an agenda, and determines amount of resources.

Mattias discusses a Kanban project board. The Kanban board is elaborate and has a breakdown such as analysis, design, and development. The purpose of the Kanban board is to get activities completed faster by making it as clear as possible as to what step each participant is in regarding the current task.

Case Study: Agile in Construction

Centrus Energy Corp. Applying certain Agile Manifesto principles to Construction, Glenn Straçusser

Agile promotes customer satisfaction through early and continuous involvement. To allow this to work for construction, there needs to be a focus on delivering functional systems to test and operation. Turnovers need to be as soon as practical, avoiding a single massive project turnover. A problem with Agile is that it embraces change. Construction does not due to the exponential cost increase as the project moves forward. An outstanding quality of Agile is it embraces cooperation which is the route construction has been moving in the past decade with project delivery strategies such as Design Build and Integrated Project Delivery. This cooperation is across all levels of the organization and is focused on face to face interaction. This can transition to construction by “minimizing organization silos and using a team approach rather than adversarial approach. To maintain this face to face interaction, it is recommended to have integrated meetings to share information rather than electronic sharing. Particular to this case study, there was an off-site designer. To solve this problem and maintain collaboration and “team”, a designer’s assistant was stationed on site.” (Straçusser, 2015). Support and motivation needs to be implemented in these meetings to foster a team environment and maintain moral. A way the team in this case study maintained this moral was through project goals and milestone progress. One of the goals was to keep productive hours productive and focus on these hours. An integrated method of agile, which promotes a learning environment, is to at regular intervals reflect and adjust. If there are complications, use root cause analysis and discussion of the causes of various complications and problems. During these meetings open discussion of ideas for improvement during meetings discussing certain topics such as lessons learned, how to improve, eliminate barriers, and how to make safer. A problem the team found when implementing agile on this project was the formality of these meetings. The beginning formal meetings felt forced with non-value added. Adjustments to the later project meetings were on an informal basis. Methods of implementation of Agile on the project began with training and development on Agile, producing a benefit to the company and employee. At the end of the project the overall cost was significantly lower than compared to the traditional method.

Selected Lean management principles to be applied

The Toyota way: 14 management principles from the world’s greatest manufacturer, J. K. Liker
When looking into “The Toyota Way”, I decided to select specific management principles described. “Principle 1, create continuous process flow to bring problems to the surface. This reduced the amount of time the project is sitting idle to zero, links processes and people together, and make flow evident a part of the culture. Principle 3, use pull systems to avoid overproduction. This allows for a responsive day-to-day shifts in demands. Principle 4, level out

the workload. Managers need to work to level out workload which aims to eliminate overburden to people. It is alternative to a start and stop approach. Principle 5, build a culture of stopping to fix problems to get quality right the first time. To assist this, it is recommended to develop a visual system to alert the team of problems. Utilize support systems to quickly solve problems. Development of a culture around stopping or slowing down to get quality right the first time. Principle 6, standardized tasks are the foundation for improvement and employee empowerment. This is the notion to use stable and repeatable methods everywhere to maintain the predictability, regular timing, and regular output of your processes. Allow for individual expression to improve upon standards. Principle 7, use visual controls so no problems are hidden. Simple visual indicators are used to help people determine immediately whether they are on track or not. Avoid using computer screens as it moves focus away from the workplace. Design simple visual systems at the place the work is done to support flow and pull. Principle 14, becoming a learning organization through relentless reflection and continuous improvement. Use reflection at key milestones and after you finish a project openly identify all the shortcomings of the project and develop countermeasures.” (Liker, 2011)

Case Study: Reasons for Lean application

The Toyota way: 14 management principles from the world’s greatest manufacturer, J. K. Liker
In this Case Example: Job Summaries in a Navy Repair Facility, the 14 management principles were applied to a Navy Repair Facility (Appendix Table 1). There was a heavy problem diagnosing and problem solving each repair situation because they were unique. An improvement was to develop a cross functional work cell and eliminating handoffs. Improvements in categories such as required non value added days, pure non value added wait time, total lead time, travel distance of paperwork, number of process steps, and handoffs increased from 55%-95% (Appendix 1.1). This case study shows the validity of the application of the 14 management principles. (Liker, 2011)

The Importance of Culture

This American Life Podcast Nummi 2015, Ira Glass

A final aspect of the management system which is the glue that bonds is in the culture around the board. I looked to a podcast based on a Joint Venture that involves Toyota and GM and a manufacturing plant. “At manufacturing plant named NUMMI, Toyota showed GM all of its secrets. At the time, the NUMMI plant was failing and risked closure. Toyota showed GM exactly how it made some of the best-built, most reliable in cars the world back then. The NUMMI plant became a success. The year following GM attempted to replicate the success of NUMMI at a second plant, Van Nuys. It however was a failure.” (Langfitt, 2010) GM attempted to replicate what they saw at NUMMI. The problem was, the “Toyota Way” could not just be

replicated visually, it needed to be replicated by the culture as well. There was a lack of communication between the plant managers and the employees at Van Nuys. This communicative and collaborative culture existed at NUMMI, but not Van Nuys. The Van Nuys plant failure is a result from only focusing on the replication of physical attributes of NUMMI, rather than the interconnected system of communication, collaboration, and employee value. This case study of NUMMI's success and Van Nuy's failure shows the underlying importance of the culture within the work environment and around proper management.

Iterative Process of Design and Development

Initial Trial

The initial trial for Construction Agility was performed during the Associated Schools of Construction, Integrated Project Delivery Competition 2017. This seventeen hour competition was with a project team of six members competing against twelve schools. The project team worked in a fast tracked competition in a small environment. The first iteration of the Construction Agility board can be seen in Appendix Table 2.

Integration of Industrial Engineering

Agile mirrors the lean principle of Plan-Do-Check-Adjust. The “check-adjust” portion is applied to the “review” portion of Agile. If the task need be adjusted or corrected after it has been reviewed by the project coordinators, a root cause analysis is performed. A problem solving A3 can be used to document the process to provide context to the review such as a background, current condition, goal, root cause analysis, countermeasures, confirmation, and future. Within the specific root cause analysis portion, a fish bone analysis or 5 whys analysis is used for brevity.

Team Reflection and Interviews

March 15th, 2017 - Camille La Cour

“I liked the board system because it helped me keep track of my own tasks, dedicate focused attention to whatever task I was currently on, and inform my teammates of my workload and focus. It was like constant nonverbal communication. I think the timed huddles could've benefited from having a little pre-planned agenda in tangent with our milestones. That way, each person could quickly prepare what they need to say and then relate their current tasks and status to the team's overall milestones.”

March 15th, 2017 - Pierre Abdel-Malek

“I honestly think the management system was really good. It just wasn't executed properly. Mainly the teams fault not yours. The team didn't believe it was necessary for the competition and did their own thing. Adding incentives maybe or just making sure that people will use it will allow it to be effective. If it's just one person trying to do it, it won't be effective. Team involvement is key to your management strategy.”

March 15th, 2017 - Carter Sandzimier

“I thought the management system did a great job of tracking workflow for each member of the team. I think knowing where you can help others on the team (or they can help you) gives more overall transparency to the management of a project. I remember we discussed pull-planning before setting up the management system (the white board). I think those two strategies work really well together in terms of knowing what needs to be compete for the next guy to do his work. I think the management system requires a lot of consistent organization on all fronts Everyone would need to constantly update their workflow, break down larger assignments into smaller tasks, and communicate their workflow to others. The Reno competition was a small scale project. On a larger project, I could see the system running into some organizational issues if not managed or used correctly. I think it would be a good idea to address how those changes in task assignments/scope would affect its organization. Address how/who would manage the overall project workflow, and how this smaller scale management system would be beneficial in doing so. Maybe address how implementing the change to this management system would look (on-boarding, training, tech utilization, etc.)”

Refined Reflection

Exceptional aspects of Construction Agility from the competition was the ease to keep track of time and tasks, visual aspect of team member's deliverables, the increased collaboration and help efforts from other team members, and limited multiple in-progress tasks resulting in efficient completions. Needs for improvement were a pre-planned agenda in tangent with deliverables for more concise meetings. Team involvement and culture around the board lacked as well. This can be averted by a stronger introduction, hands-on training, on-boarding process of the board, use of incentives, and/or contractual agreements. It was difficult to estimate certain durations which can be fixed by a further breakdown of tasks. It is also notable that collectively as a team we all agreed that this management system may not be valuable for a larger, more extensive job.

Dealing with a Traditional Industry

Socialization

The construction industry is very interesting in terms of culture. The industry is very traditional, partially egotistical, and resistant to change. Dealing with subcontractors and managing them can

be very difficult at times for the general contractor. One way to ease the transition to Construction Agility and the change the subcontractors will be experience is to use terminology that is common in the industry. The original Agile Management system uses terminology derived from the software industry where it was developed. When dealing with general contractors and subcontractors in construction, I looked to ease them into the Construction Agility system with terminology they have heard previously. These changes are “scrum” to “daily huddle”, “Kanban” to “Batch Board”, and “Stories” to “Backlog”. An on-boarding process should be used as well for familiarity reasons of the system. Not only showing, but practicing the system is needed from the general contractors to bring the subcontractors on board with this system. In this aspect, the general contractors must practice what they preach.

Industry Interviews and Refinement

Throughout the development of the system, I interviewed several general contractors. Below is a summary of those interviews.

March 2, 2017 - Tavier Darchangelo, Regional Manager - Whiting-Turner Construction

We discussed the potential problem and need to get stakeholders onboard with the system. Putting the system in perspective of size of the applicable project, it may be more valuable for certain smaller market sectors. An attribute that was praised was that the system is a simple and straightforward overview tool for the project manager or superintendent concerning big issues. The project managers are not always at every meeting and the system maintains a great way to keep track and keep accountability. This attribute of accountability can not only be utilized internally for the general contractor, but also in the subcontractor meetings to maintain subcontractor accountability. The visual representation helps for tracking subcontractors and their completed tasks, giving an insight of whether they are on schedule or not. At this point there may be a need for incentives or a scorecard for subcontractors to stay on track. The largest exposed flaw from this interview was that the system is not the best in regards to formal documentation and should stay on the lines of an informal tracking tool. Further adjustments from the initial iteration of Construction Agility is the application to subcontractors, additional subcategories under the responsible engineer or foreman while maintaining simplicity.

March 2nd, 2017 - Michael Conroy, VP of Operations - Level 10 Construction

Michael recommended to look to Weekly Work Plans and Pull Planning for more potential ideas in developing the system. There was an emphasis to focus on handoffs and the flow of the system. For subcontractor tracking with a pull planning visual system using different colored sticky notes/cards per trade with additional constraints and handoffs listed on each. A concern was how to get subcontractors on board. This can be done contractually. The general contractor needs to “practice what they preach” to promote value of the process and a better return on investment. This can create a cross accountability with subcontractors in the sense that “no one

wants to be that guy” that is delaying the schedule. Further adjustments from this system is to use different colored sticky notes, add constraints, and add handoff dates.

March 12th, 2017 - Chase Corcoran, Superintendent - Webcor Builders

When getting input from a superintendent, there was a big focus on management of the subcontractors and issue resolution. What is needed is to determine the process for issue resolution. This may result in contractual agreements and setting issue resolution deadlines to stay on schedule. There was also a desire to incorporate interdependence of subcontractors bringing back the focus to handoffs.

March 28th, 2017 - Brett Curry, VP of Operations - C.W. Driver Construction

Brett insisted in potentially mimicking a hotlist concept which focuses on more important tasks such as critical activities. There needs to be an agreement among participating parties to dates to maintain accountability through contractual agreements. In regards to management of the system, consider having a deeper breakdown structure, consequences for missing deliverables, and informal issue resolution to continually foster a collaborative environment.

Second Iteration

The second iteration of Construction Agility is based off the previous board and the adjustments made following the competition and interviews. The board now instead of a “To-Do” batch, is now named “Weekly To-Do”. This is to not only assist in the organization aspect but also to maintain the frequency of meeting weekly and updating the board. What would normally be filled in the “To-Do” batch is now moved into a newly introduced “Backlog” batch. This allows for projects of work weeks ahead. Each responsible participant now also has color coded rows on the Construction Agility board. Coordinated with the color of the responsible participant are color coded cards. These cards list the activity, the duration, and the next in line party. This helps with visual aspects and handoffs. (Appendix Table 3)

Recommendation

I recommend that the on-boarding process for introducing Construction Agility be presented in tangent with the safety orientation. A safety orientation is a serious introduction to new contractors on the jobsite and by doing both together shows the importance of Construction Agility. There is a need to facilitate a team and learning culture around the board. This is done by periodic reflection and input from participants. To maintain quality, a “champion”, whom of which would be a project manager or superintendent, is the participant that is designated to move cards from the “review” batch to the “complete” batch. Weekly huddles and daily huddles need to be utilized to maximize communication of handoffs. These weekly huddles need to occur at the start of each week. During these focused meetings there are three questions that need to be asked, “What I have done”, “What is preventing me from completion” and “What I plan to-do

next”. During these weekly and daily huddles, the champion needs to have a pre-planned agenda that is used in tangent with deliverable to keep the meeting focused and on track. When issues arise, preferably it would be informally resolved though that will be determined contractually. Finally, a use of incentives or contractual agreement might be used to ensure participation.

Final Scenario, Critiques, and Product

I took this established system to a construction management professor at Cal Poly, Jason Hailer. With him I ran through a scenario and critiques. His concern consisted of the subcontractors untruthfully updating the board in order to stay out of negative light if they are not making schedule. A solution to this is either contractual agreements or simply use subcontractors that are willing to participate in such a system. A second recommendation to refine Construction Agility was to use two boards instead of one. One of the boards will consist of the general contractor’s project team and remain in the job site trailer. The second will consist of the subcontractors and remain on the outside of the jobsite trailer. This will enhance accountability and safety for visitors as it is a type of signage promoting awareness of job site activities. A final recommendation to help with task identification is to display critical activities. This will be more focused for subcontractors rather than the general contractor. The final iteration and example on a jobsite can be seen in Appendix Table 4, Image 1, and Image 2.

Reasons to Implement

To this entirety, this is Construction Agility. With the previous recommendation in combination with the final scenario and critiques completes Construction Agility. This tool uses simple visual concepts that are measurable. Construction Agility promotes accountability, collaboration, safety, awareness, learning, and quality.

Construction Agility’s Value

Lastly I want to state that this tool is not intended for all job sites and project. It is more for fast tracked projects, high collaboration contracts, critical and highly involved clients, and smaller/mid-sized design build or integrated project delivery. A unique thing about Construction Agility though it’s power to differentiate. It can be used to create a new company dynamic and identity. For this reason, it can be of great value to start-ups as well as companies dealing with a change of leadership.

Appendix

Table 1

	Before	After	Improvement
Value-added time (days)	15	15	0%
Required non-value-added time (days)	20	8	60%
Pure non-value-added wait time (days)	62	3	95%
Total lead time (days)	67	26	73%
Travel distance of paperwork (feet)	30744	2500-14000	55-92%
Number of process steps	70	23	67%
Handoffs	58	10	80%

Table 2

	To Do	In Progress	Review	Complete
Remington				
Camille				
Pierre				
Carter				
David				
Jeff				

Table 3

Backlog	Responsible	Weekly To Do	In Progress	Review	Complete
	Project Manager				
	Project Manager				
	Superintendent				
	Superintendent				
	Project Engineer				
	Project Engineer				
	Subcontractor				
	Subcontractor				

STEEL ERECTION
Duration: 10 Days
Next In Line: Exterior Enclosure

Table 4

Backlog	Responsible	Weekly To Do	In Progress	Review	Complete
	Project Manager				
	Superintendent				
	Office Engineer				
	Field Engineer				

Backlog	Responsible	Weekly To Do	In Progress	Review	Complete
	Mechanical Sub				
	Electrical Sub				
	Plumbing Sub				
	Fire Protection Sub				

Image 1



Image 2



Works Cited

Liker, J. K. (2004). *The Toyota way: 14 management principles from the world's greatest manufacturer*. New York: McGraw-Hill.

Straçusser, G. (2015). Agile project management concepts applied to construction and other non-IT fields. Paper presented at PMI® Global Congress 2015—North America, Orlando, FL. Newtown Square, PA: Project Management Institute.

Glass, Ira. (2015). This American Life Podcast Episode 561: NUMMI.
<https://www.thisamericanlife.org/radio-archives/episode/561/nummi-2015>

Thomsen, C. and Sanders, S. (2011). *Program Management 2.0*. McLean, Va.: Construction Manager's Association of America Foundation.

Yllen, Mattias. (2012) Agile project management in the construction industry - An inquiry of the opportunities in construction projects. KYH Vetenskap Och Konst.
https://www.kth.se/polopoly_fs/1.339912!/Menu/general/column-content/attachment/Mattias_no148.pdf

Agile Management. (2017). In Wikipedia. Retrieved June 1st, 2017 from https://en.wikipedia.org/wiki/Agile_management.

Lean Manufacturing. (2017). In Wikipedia. Retrieved June 1st, 2017 from https://en.wikipedia.org/wiki/Lean_manufacturing.