Cleary, J.W., and Munoz, A. (2018). "Reaping the Rewards of Production Tracking" In: *Proc. 26th Annual Conference of the International Group for Lean Construction (IGLC), González, V.A. (ed.)*, Chennai, India, pp. 1144–1149. DOI: doi.org/10.24928/2018/0494. Available at: www.iglc.net

REAPING THE REWARDS OF PRODUCTION TRACKING

John Cleary[1], Anthony Munoz[2]

ABSTRACT

Traditionally, project controls translate to "monitoring results." In a *true* lean project, it is redefined as *"making things happen," with a measured and improved planning process to assure reliable workflow and predictable project outcomes* (Lean Construction Institute). By monitoring productivity, a Project Team can more effectively identify and respond to "hot topics" that may hinder flow and predictability. The consistent communication of this information provides the transparency needed for decentralized decision-making, empowering the Project Team to take action and maximize value.

Through an Integrated Form of Agreement on a Southern California healthcare project, self-performing Constructors tracked and reported productivity. This information was used to provide *real-time* updates to schedule, production planning, and budget forecasting. These metrics were compared to the original rates, serving as key performance indicators. Underperforming critical activities would be earmarked to conduct a Deming Cycle for improvement. Activities with high measures would be assessed to identify factors contributing to their success or if the baseline was ill defined. Ultimately, this information was used for Continuous Improvement with a goal of reducing overall schedule in productivity improvements, reducing overall budget by way of production savings, and contributing to and maintaining a positive work environment.

KEYWORDS

1) production planning, controls 2) Integrated Form of Agreement 3) job-sequencing 4) target cost 5) team morale

INTRODUCTION

This industry paper observes an Integrated Form of Agreement (IFOA) project on which weekly productivity tracking and reporting were utilized to influence delivery, design, construction, and Team morale. The objective is to share what benefits this Project Team gained from Constructors tracking and reporting actual production rates of work-in-place to all Integrated Project Delivery (IPD) Partners throughout the life of a construction project.

[1] DPR Construction, 4665 MacArthur Court, Newport Beach, Ca. JohnCl@dpr.com
[2] DPR Construction, 4665 MacArthur Court, Newport Beach, Ca. AnthonyM@dpr.com

BACKGROUND

This study is within the field of construction project management where the critical success factors of scheduling, budget and team morale are analysed, specifically the influence productivity tracking and reporting and its corroboration to overall project success.

Studies have shown that time wasted during construction is attributable to poor management practices. Fischer et al. (2017) provides that successful production planning can only be accomplished when the Production Management Team understands the scope and pace of work necessary to achieve the defined milestone goals. A production schedule must represent real capabilities under real-world conditions, utilizing a rapid feedback loop to incorporate what is being learned from ongoing work. The Team must also be able to review progress and quickly determine if production, safety, and quality objectives are being met. This is the role of productivity metrics.

This submission aims to identify the benefits of productivity tracking, reporting, and metrics as it pertains to schedule, budget, and Team morale.

METHODOLOGY

The content of this industry paper is the product of its authors' experiences through action learning. Action learning is a means of development that requires responsible subject involvement in some real and complex problem, to achieve intended improvement (Revans, 1982: 626-627). This concept is based on the premise that learning emanates from reflection followed by action to solve real problems (McGill and Beaty, 1995) where reflection and discussion occur in small groups.

ACTION LEARNING –AUTHORS' EXPERIENCE

The Temecula Valley Hospital Imaging Project is a 28,000sf first floor expansion providing facilities for a hybrid operating room, a biplane angiography room, 2 cath labs, 7 PACU bays, 7 pre/post bays, 1 CT scanner, waiting area, community room, OPS/bulk storage, 3 operating rooms, and shelled space for one additional imaging room. The project was built as an Office of State Health Planning and Developing (OSHPD) 1 under the 2013 California Building Code.

The Owner, Universal Health Services (UHS), identified and selected IPD Partners utilizing a Choosing By Advantages (CBA) methodology. UHS has been a pioneer of employing this delivery method in Southern California and throughout the United States, citing its inherent promotion of collaboration and incentive based Target Value Design (TVD). Partners for this project included the Architect, Structural Engineer, Electrical Engineer, Civil Engineer, Mechanical/Plumbing Engineer, General Contractor, Concrete/Framing/Drywall Contractor, Electrical Contractor, Mechanical/Plumbing Contractor, and the Owner.

Each of these Partners placed their respective profit pools at-risk and were additionally incentivized with an enhanced profit pool if the Project was completed and satisfied several performance criteria. Of these criteria, completing the project 4 weeks ahead of the original contract schedule represented 50% of the available enhanced profit pool. As

such, the Project Team prioritized value engineering and improvement suggestions to meet this objective resulting in a greater attention, analyzation, and utilization of production planning.

In this Case Study, the problem/objective goal was to optimize schedule to satisfy the performance criteria which represented 50% of the available enhanced profit pool, requiring completion of the project 4 weeks ahead of the original contract schedule. The Project Team prioritized value engineering and improvement suggestions to meet this objective resulting in a greater attention, analyzation, and utilization of production planning.

The remainder of this section will address how production was benchmarked, tracked, analysed and reported, specifically by the Framing/Drywall Contractor. It should be noted that the Electrical and Mechanical Contractors used similar methods and analytics but are not being represented herein.

DIGITAL PRODUCTION TRACKING

Digital Production Control is a software based program that was used to create baseline metrics using the original estimated take-off of systems, units, and quantities. When a particular system is selected, percent complete and the associated work breakdown structure along with committed costs are also provided. Each week, responsible Team members, such as superintendents, foreman, project managers, or project engineers, would log work in place by actual measured units or percent complete. Figure 1 provides an example of Digital Production Tracking. As shown in Figure 1, work in progress is denoted by the red highlighting.

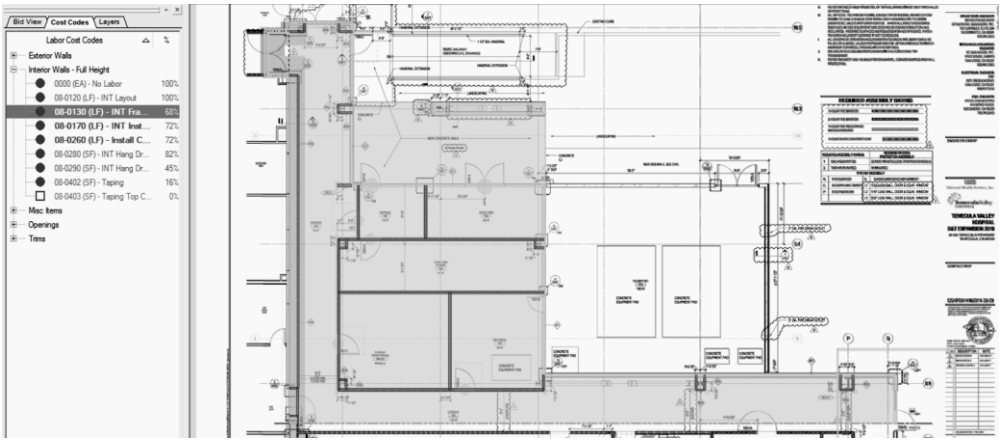

Figure 1: Digital Production Control Screenshot on12/15/2017

REPORTING PRODUCTION

Using a project management or data collection software, in this case CMiC, quantities of work in place were logged on the Friday of the week they were actualized. Labor Transaction Reports, which tabulate and summarize labor hours expended on each cost

code, were also processedeach Friday and by the Tuesday of the following week, a production report could be gathered and presented to the Project Team.

Figure 2 provides an excerpt from a Production Tracking Sheet used by the Framing/Drywall Contractor. Production rates are represented by the quotient of quantity complete over man hours expended on the respective cost code. This rate was then compared to the originally budgeted rate. A macro was created to determine the quantities remaining and projected hours to complete based on the actualized production rates as of the data date. The difference in budgeted vs actualized rates were represented as Projected Variance. Collectively, this information provided a high-level barometer of activity efficiency. These reports were presented to the entire Team during weekly Big Roomand addressed as needed.

	Budgeted				Current Job to								Projected
	Quantity		Hours		Thru Week Ending			% Complete		Projected	Remaining		Variance
Phase Description	Budget	U	Budget	Rate	Quantity	Hour	Rate	Quantity	Hours	Hours	Quantity	Hours	= (-Over
INT Layout	4,791	lf	256	18.7	4,424	152	29.1	92%	59%	165	367	13	91
Int Frame Walls	3,609	lf	2,815	1.3	3,123	1,535	2	87%	55%	1,782	486	247	1,033
INT Beam Stickers	1,019	ea	112	9.1	990	84	11.8	97%	75%	86	29	2	26
INT Top Track/Plate/Bolts	4,200	lf	680	6.2	3,621	364	9.9	86%	54%	422	579	58	258

Figure 2: Partial Drywall Production Report run 12/05/2017

RESULTS AND BENEFITS

IMPROVEMENTS IN DESIGN

The project experienced multiple instances in which production tracking and the consequential reporting resulted in design changes throughout each of the stages of the project. While "rework," in this instance redesign, is one of the eight deadly wastes, the Team more critically valued Deming's philosophy of plan-do-check-act for continuous improvement, employing in its most immediate applications. Ultimately, this compromise was made in the investment for a greater overall value to the project.

A specific example of this involved the framing design/detail for top track installation. The original design called for a heavy gauge track which was to be screw anchored into the corrugated metal decking above with fire protection stuffing in the void between the decking and the top track, as required. The budgeted production rate was 6.2 linear feet of track to be installed per man hour. The installation of this detail proved to be a challenge for the installing carpenters. Using production tracking, an actual rate of 4.9 linear feet of track per man hour was recorded. Not only did the over-the-head material handling and effort to install the screw anchors prove to be inefficient, but it also proved to be unsafe. This decline in production was immediately reported to the Big Room.

The Team identified this matter as a "hot topic" and swarmed the issued. Following this effort, a more efficient, more safe, and still code compliant detail utilizing shot pins in lieu of screw anchors was recommended and approved. That very day, the carpenters were installing per this revised detail. The final actualized production rate was calculated to be 9.9 linear feet per man hour. This exercise alone saved the Project Team upwards of two hundred and twenty hours, amounting to $18,307. This collaborative effort by the

entire Project Team not only contributed to lowering the final PTC with cost savings, but also helped to improve the overall project schedule, allowing critical mechanical/electrical/plumbing overhead activities to start 6 days ahead of the original scheduled dates.

BUDGET ACCURACY

As illustrated in the provided example, productions savings can be substantial. When utilizing an IFOA/IPD delivery method, savings such as this contribute to funding the profit pool or even an enhanced profit pool, that is shared amongst the signing Partners. To the contrary, fluctuations in productivity could be the source of the greatest risks to a PTC. A 2013 research article from the Alexandra Engineering Journal, *Applying lean thinking in construction and performance improvement*, that the productivity of the construction industry worldwide has been declining over the past 40 years. (e.g., Aziz et al. 2013) The Lean Construction Institute (LCI), corroborates this study, citing that over 70% of construction projects are over budget and delivered late.

In order to effectively manage the PTC, budget, and schedule, a Project Team must constantly monitor primary contributors. By monitoring and reporting productivity tracking and resulting production rates, a team can create a key performance indicator (KPI) representing the collective of primary contributors as one. In the instance of the subject project, the Team utilized this KPI reading to adjust course such as to avoid greater impacts to both budget and schedule. Additionally, the regular reporting of overall PTC served as a second KPI for original estimates and budget. This information serves as a gauge for the need of immediate value consideration, if critically necessary, to maximize value at the project level as opposed to attempting to optimize every activity. If not critically important, this information would be used to inform estimating and budgeting endeavours for future improvements – i.e. continuous improvement.

MORALE

Collecting data on morale and team bonding can be challenging compared to quantifying the impacts on the previous two topics of budget and design. That being said, it is a testament to the team that productions rates increased as reports of production were released to the construction workers at a weekly production review meeting. These meetings were held onsite, during the middle of the week. There was lots of feedback early on in the process that the construction workers took these production rates very seriously and enjoyed being able to see the rates in which they were hitting. Workers were constantly asking questions about the rates, quantities and hours.

Construction workers weren't the only team members showing an interest in actualized production rates. On multiple occasions, design team members while doing job walks or on the phone asked about production rates. It was noticed that during design changes, the engineers and architects would call the trade partners and ask for their opinion on the most efficient way to design and install the change. This camaraderie helped build confidence in our builders and design in each other and created a sense of considerate for the craft.

By having these open levels of communication, not only was more attention spent on diving into the details of the project but also know the budget and scope including in all the line items. It is the team's belief that this lead to higher morale and pride amongst the workers and lead to eliminating rework on the project.

CONCLUSION

There are three main benefits of accurately tracking, analysing and reporting production rates throughout the life of a construction project. Design is optimized for improved efficiency and increased safety of the installing craft. Budget is accurately and timely being tracked, forecasted, reported and used as a KPI for overall project health. Morale is improved though camaraderie and a shared sense of pride amongst all levels of the Project Team – from inception through execution. Based on its actualization of these benefits, this Project Team recommends that all projects, IFOA/IPD or other, employ regular production tracking, monitoring and reporting for improved project health.

REFERENCES

Aziz, R.F., Hafez, S.M., (2013). "Applying Lean Thinking in Construction and Performance Improvement." *Alexandria Engineering Journal.* Volume 52, Issue 4, December 2013, 679-695.

Ballard, G., Howell, G.A., (2003) "An update on Last Planner." *Proceeding of the 11th Annual Conference of International Group of Lean Construction*, Blacksburg, VA.

Fischer, M., Ashcraft, H., Reed, D., Khanzode, A. (2017). *Integrating Project Delivery*. Wiley, Hoboken, New Jersey.

Lean Construction Institute. "What is Lean Design & Construction." <https://www.leanconstruction.org/about-us/what-is-lean-design-construction/> (2017).

Liker, J.K. (2004). *The Toyota Way*. McGraw-Hill, New York, NY.

McGill, I. and Beaty, L. (1995), *Action Learning*, Kogan Page, London.

Revans, R. (1982),.*The Origins and Growth of Action Learning*, Chartrell-Bratt, Bromley.