A New Assignment Sizing Criterion
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Questions and comments are not only welcome but eagerly awaited!

The quality criteria for assignments are definition, sequencing, soundness, sizing, and learning. Most efforts to improve PPC and the plan reliability it measures have focused on definition and soundness. One of LCI's research goals for this year is to discover how to increase PPC to the 90% plus range, which we believe will increase productivity substantially. Four actions are key:

1) full empowerment of last planners to refuse assignments that do not conform to quality criteria,
2) consistent analysis and action on reasons for failing to complete assignments,
3) further improvement in definition by using First Run Studies in construction and Activity Definition Models in design, and
4) adopting a sizing criterion for assignments that consistently demands less output from production units than their estimated capacity.

This White Paper is about the sizing criterion.

Definitions

I have changed my mind about one aspect of Last Planner. The issue is sizing assignments to the capacity of production units. First a few definitions.

- A production unit (PU) is an individual or a group performing some production tasks. PUs receive assignments. Most PUs are construction crews or design squads.
- Capacity means how much work a PU can do at any point in time with given tools and work methods in given conditions. A crew may be able to produce 50 units of output (linear feet of pipe, tons of steel, cubic yards of concrete, etc.) under current conditions. That is their capacity; the amount of work they are capable of accomplishing.
- Load is the amount of work we demand or expect of a PU. Common practice in construction at present is to load to 100% of estimated capacity. In our example, that means we would assign 50 units of output to be produced by the crew each day.

Variability in productivity and in work flow (plan reliability)

Loading at 100% of capacity is acceptable when capacity is accurately predictable and when there is insignificant variation in the flow of work to the construction crew or design squad.

Unfortunately, actual production varies widely over time even for a single PU, and varies even more widely across different units. In addition, as we all are aware, work flow is not highly reliable. Indeed, even when we try to make good assignments, PPC is now often below 70%. In such circumstances, loading at 100% capacity decreases the probability that assignments will be completed as planned.

Coming from another angle, we can assume that there is a 'natural' variability of capacity even when methods, technology, and conditions are fixed. Further, there is the difficulty of accurately estimating even average capacity when there are changes in these variables or when the type of work changes or there is some change in crew or squad composition. Since we don't make identical products in controlled conditions, capacity variation is a fact of construction life. Current production management techniques ignore this fact.

Besides the fact that capacity is variable, the second key fact is that capacity can be increased by reducing non-productive labor time. Further, non-productive labor time falls with increasing PPC.

Underloading can reduce the immediate productivity of a PU, assuming that no non-schedule-driven work (workable backlog) is available to absorb unused capacity. However, underloading assures that the PU's plan reliability or PPC is higher, thus providing better advance notice to downstream PUs of work flowing toward them, and thus allowing them to increase their productivity. Since all but the very first in a chain of PUs receive work from others, potentially all benefit from adopting practices that improve PPC. Consequently, the next step in improvement of both plan reliability and productivity will most likely occur on projects where the various design and construction specialists practice some form of gainsharing, or at least collectively recognize their interdependence and potential gains. Otherwise, no one will be willing to sacrifice, even temporarily, for the sake of the whole.

We can say that initial, unilateral improvements in PPC and productivity need now to be superceded by collaborative improvements in PPC and productivity based on increasing the predictability of work flow across PUs.

Don't load to 100% of capacity

In earlier writings, LCI advocated sizing assignments so they fully absorbed the productive capacity of those to whom the assignments were made. I now believe it would be better to underload production units in order to allow for variability in capacity, which is itself partially a function of variability in the flow of work to those production units. Underloading reduces the achievable output of a PU. They have more capacity than load. However, underloading also increases the capacity (potential productivity) of following PUs through its impact on work flow reliability.

Impact of Sound Assignments

It makes sense that the productivity of a production unit increases when we make more assignments to that unit that are sound; i.e., assignments from which all constraints have been

removed. Design information is current, materials are on hand, work space has been allocated, etc. More of total labor time is spent actually doing work instead of looking for materials, switching between tasks, and returning to finish work left incomplete.

BEFORE:

- initial average capacity is 50 units per day.
- 50% of the labor hours expended to produce that 50 units are actually wasted on rework and nonproductive waiting, looking, revisiting, etc.
- PPC of the PU is 50%.

AFTER:

- PPC increases to 70%, as a result of improving the soundness of assignments.
- nonproductive time (delays and rework) falls to 35% vs. the previous 50%.
- new capacity is 65 units per day.

This amounts to a 30% improvement in capacity of the production unit. Previously 50% of total labor hours were expended in the production of 50 units of output. Assuming no change in skills, effort, technology, or work methods, after the improvement in the soundness of assignments and consequent increase in PPC, the PU expends 65% of its total labor time on production and produces 65 units of output. Note that LCI has in fact found a 30% improvement in productivity of PUs on numerous occasions when PPC has been improved largely as a result of making sound assignments.

Potential impact of the new sizing criterion

With PPC at 70% throughout a chain of PUs, a PU still has considerable uncertainty about what work is actually going to be released to it by upstream PUs only one move away; usually as little as one week in advance. LCI suggests that the next wave of increases in PPC will come from a number of different initiatives, including sizing to the new criterion; namely, underloading sufficiently to allow for variability in PU productivity. In the absence of real data, I suggest that you try loading at 90% of the estimated capacity of PUs, then adjust as needed.

I expect this underloading to improve PU PPC, thus increasing the lead time downstream PUs have to make work ready. Speculative results:

- loading is at 90% of capacity; i.e., 59 (58.5) units are assigned to be produced each day.
- productive time increases to 80% from the previous 65%
- new capacity is 80 units per day.

What happens when sizing combines with soundness?

Underloading upstream production units increases the capacity of downstream production units, just as making only sound assignments increases the capacity of the production unit receiving those assignments. Assuming that we continue to load at 90% of capacity and that the new capacity is 80 units per day, load and productivity would be 72 units per day—an additional increase of 23% above the 58.5 units previously achievable—and a 44% improvement above the initial 50 units per day. However, as rising PPC reduces variation in capacity, we can increase load accordingly, thus further improving productivity. Supposing a 95% loading, output would be 76 units, an improvement of 52% above the initial 50 units per day.

This 52% improvement in productivity results only from increasing the percentage of paid labor time available for production. The other variable determining capacity is the fruitfulness of productive labor time, which is a function of operations (work methods) design, design constructability, skills training, and worker motivation. The 5-10% nonloaded time will be invested in precisely these areas. In fact, we may find it beneficial to keep loading at 90% or possibly even less in order to free labor time for investment in fruitfulness. Workers will be asked to spend time doing First Run Studies or defining design activities; providing feedback to upstream players on the adequacy and clarity of design criteria or design constructability; undergoing training in craft and managerial skills; etc. etc. We breakeven if we invest 10% of paid labor time and increase capacity enough to offset that cost; i.e., in our example, increase from 72 to 79 units per day.

If this analysis and these numbers are plausible, you can see the tremendous potential for improvement offered by lean construction concepts and techniques. Current productivity levels will be eclipsed and become irrelevant.

Overmanning

Those who have been in conversation with us for a long time might wonder if we have forgotten our own experiences on projects. We have seen consistent overmanning on large industrial projects; an attempt to have enough workers in place to do whatever work happens to become available. We have been very harsh in our judgment of this practice. Was this actually a type of underloading, a practice we are now advocating? Should we apologize to all those project managers we previously criticized?

We don’t think we owe any apologies. Just because we have workers doesn’t mean we have capacity. Capacity is a function also of what work there is to do and the quality of assignments which load that work onto the workers. We criticize managers who only manipulate job manning and neglect work flow. The overmanning we criticized in the past was not done to increase work flow reliability. In fact, it usually made it worse. Further, the actual capacity of an additional worker often was either insignificant or negative. Very low percentages of paid labor time was spent actually working. Additional workers added congestion and increased demands on scarce resources (tools, information), resulting in further degeneration of labor utilization, to the point that despite apparent overloading, real capacity wasn’t sufficient to do the work that did happen to be available.

The point here is that we must learn to manage work flow together with ‘manning’ to increase both plan reliability and productivity.

Moving forward

Underloading is better than overloading because it helps improve PPC, which ultimately helps improve productivity. We need to learn how to better estimate capacity and its variability in order to underload just enough to assure high plan reliability. Since variability reduces with increasing PPC, that makes our task easier.

I recommend that you initiate all the actions needed to improve PPC (see first paragraph). Also, before adopting this new sizing criterion, examine your current plan failures to determine what percentage result from overloading, and also what percentage result from poor definition, unsound assignments, etc. Causes may be hidden behind intermediate reasons, so look closely. Please let me know what you find.

If analysis reveals sufficient opportunity, try the 90% loading and observe its impact on your productivity, on PPC, and on the productivity of downstream PUs. If several member companies participate, we can set up some kind of information sharing mechanism, perhaps through the LCI web page, via email, and/or side meetings at LCI functions. Let me know if you’re interested or if you have questions.