Implementing Pull Strategies in the AEC Industry

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The framework for this thought piece is the idea that there are three ways to coordinate work flow; i.e., schedule push, continuous flow, and (plan) pull.

To expand, the three techniques are:

- pushing different work activities toward future intersections in time through schedules

- flow through assembly chains in accordance with pre-agreed rules for spacing, handoffs, and pace,

- pulling elements together to be assembled.

Our current thinking is that a) we need to use schedules to initiate long-lead actions, b) we need to structure work on site as much as possible in assembly chains, through which work can flow continuously, without central control, and c) we can pull most materials and ultimately design information to the site to mate with actual or predicted subassemblies.

Scheduling is now the only well recognized technique for work flow coordination in construction. Structuring work packages around assembly chains will be the subject of a later white paper. The topic here is pull.

In order to pull materials into site assembly, we need to improve in two areas: 1) Improve work flow reliability in the site assembly process, and 2) Reduce the time required from order to delivery of materials to the site. The primary benefit of pulling is shorter projects, which will result from saving the time now spent filling inventory pipelines, and from more often being able to do the work that maximally advances the project. Secondary benefits include reduced working capital tied up in inventories of materials that are not being used, less labor time spent handling materials, and less loss, damage or misplacement of materials.

Improved work flow reliability allows material delivery orders to be placed earlier relative to their scheduled installation. (Note that we now infrequently distinguish between purchasing an item of material and ordering or releasing the item for delivery.) Reduced delivery times allow orders to be placed closer to the time the work will be done. Orders should be placed within the response time of those asked to deliver materials, but current low predictability of work completion and long response times makes it necessary to ‘order’ and accept deliveries of materials further in advance, so the accumulation of inventories and longer projects is inevitable.

Let's make up some numbers. Let's suppose that we are now able to accurately (90+%) predict the completion of an item of work no more than 3 days ahead of its actual completion. Let's also suppose that it takes 5 days on average to get stuff to the site once it is requested-e.g., fabricated items such as steel or pipe. If we wait until 3 days before the work is scheduled to be done, we can't get the stuff we need, so we order it earlier and cause the waste of overproduction because of the mismatch between what's delivered and what can be immediately used in the assembly process. In fact, things are much worse because our ability to accurately predict work completion is actually closer to 1 day and because the time now required to pull fabricated items to site is often 6+ weeks. We need to get delivery time within our window of predictability and reliability. We need to close the gap by increasing work flow predictability beyond 1 day and by reducing delivery times below 6 + weeks.

That is a huge gap to be closed. How to do it? The Last Planner method (lookaheads, screening, shielding) has been developed as a means of improving flow reliability. General contractors/construction managers have the responsibility for coordinating and managing assembly processes using these techniques. Action for improving plan reliability: 1) Install Last Planner on sites, 2) Develop specialty contractor production management systems so they can provide to assembly coordination accurate status and forecast information regarding material flow.

In order to pull materials and information onto the site, we must also reduce the delivery times of fabricators, suppliers, and designers. On subcontracted jobs, the primary burden must be borne by the subcontractors. Let's divide the world of materials into process equipment, fabricated items, and commodities. Many items of process equipment are so long-lead that they do not offer themselves as initial candidates for reducing delivery times. They must for now continue to be coordinated by push schedules. Examples might include chillers, fractionation towers, electrical panels, etc. (On the other hand, we're talking to Trane about joining LCI precisely so we can work on these longer lead items such as chillers.) Some fabricated items may take 12 weeks or longer to fabricate and deliver, sometimes because of capacity shortages and having to stand in line to get shop space. However, there are medium-term fabricated items on which we might first concentrate our efforts; e.g., structural steel, pipe supports, pipe spools, metal components, etc. These are generally custom-designed, so require fabrication drawings or instructions, often provided by the specialty contractor (SC) who is to install them. In any case, let's assume the SC is providing the fabricated item, so they can in some sense 'control' delivery, or at least find out when delivery is supposed to occur.

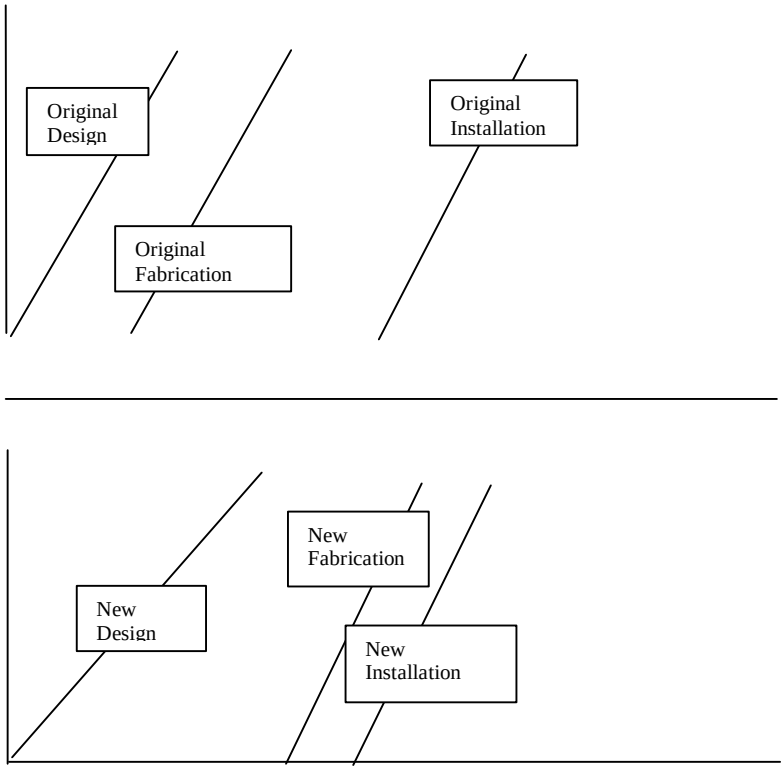
Is it possible to shift inventories from laydown yards on site upstream to a place between design and fabrication, then pull fabricated items from that point onto the site? We would need some agreements with design and with fabricators. We've done some early exploration with fabricators. They say they would charge no more or little more to fabricate and deliver to site order rather than to schedule, assuming they have design information that is correct and complete, and assuming they have that information in time to themselves acquire the fabrication materials.

Actions for reducing delivery times: 1) Build slack into the schedule for production of fabrication drawings to allow a buffer of drawings and the associated materials to be built up at the fabricator or at some staging area ahead of fabrication, and 2) Get agreement on ordering/delivery procedures and payment with fabricators for responding to short-interval pull orders, perhaps once or more per week. 3) Explore the possibility of pulling fabrication drawings to the fabricator, then ultimately in future pulling model construction (assuming that's the source of fabrication drawings or CAM instructions).

Even if early efforts do not significantly reduce duration, there are advantages to allowing design more time to make late changes and to get drawings right. However, our hypothesis is that a buffer between design and fabrication can be much smaller than the buffer between fabrication and construction now required for 'good' project performance.

We invite your questions and suggestions on this issue and seek LCI members willing to conduct experiments. Some members may already be using pull techniques. Please let us know what you are doing and how well it's working. We are especially interested to hear from members who are or can pull from their own fabrication shops.

Related writings: This idea was first presented in the paper "Toward JIT in Construction", presented at the 1995 IGLC meeting in Albuquerque. Real world need for buffer relocation and inventory reduction was demonstrated in Howell and Ballard's research on piping for the CII. Iris Tommelein's 1997 pipe spool simulation provided support for the hypothesis that pull techniques would reduce site inventories.



The hypothesis is that by allowing design time to complete drawings for a complete unit of work (activity area, floor, plant, total project), the site can pull whatever it needs from fabrication just when it's needed for installation. Assuming that the fabrication rate stays the same, the installation rate will have to also stay the same or at least not intersect the fabrication line. Productivity improvement in installation can be captured in reduced cost from reduced labor. Duration will decrease because installation can work close to fabrication.

In this schematic, design is given about a 50% increase in duration. Fabrication starts after design is complete. Construction starts right after fabrication starts, allowing only perhaps a week's worth of materials to be delivered to the site beforehand. Perhaps we can persuade Iris to model these possibilities.